Final Report - DuraMelter 100 Tests to Support LAW Glass Formulation Correlation Development, VSL-06R6480-1, Rev. 0

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

**P.O. Box 450
Richland, Washington 99352**

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Assistant Secretary for Environmental Management

The logo for the Office of River Protection features the text "Office of River Protection" in a bold, sans-serif font. The text is white and is set against a dark, wavy, brush-stroke-like background that resembles a river or a stylized wave.

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VSL-06R6480-1

Final Report

DuraMelter 100 Tests to Support LAW Glass Formulation Correlation Development

prepared by

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for

Duratek, Inc.

and

Bechtel National, Inc.

February 7, 2006

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Completeness of Testing:

This report describes the results of work and testing specified by the above-listed Test Specification(s), Test Plan(s), and Text Exception(s). The work and any associated testing followed established quality assurance requirements and was conducted as authorized. The descriptions provided in this test report are an accurate account of both the conduct of the work and the data collected. Results required by the Test Plan are reported. Also reported are any unusual or anomalous occurrences that are different from the starting hypotheses. The test results and this report have been reviewed and verified.

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Date: 3/21/06

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List of Abbreviations

AA	Atomic Absorption Spectroscopy
ADS	Air Displacement Slurry
DCP-AES	Direct Current Plasma Atomic Emission Spectroscopy
DF	Decontamination Factor
DM	DuraMelter®
DOE	Department of Energy
DRE	Destruction & Removal Efficiency
dscfm	Dry standard cubic foot per minute
EDS	Energy Dispersive X-ray Spectroscopy
EPA	Environmental Protection Agency
FTIR	Fourier Transform Infrared Spectroscopy
GC	Gas Chromatography
HEPA	High-Efficiency Particulate Air Filter
HLW	High Level Waste
LAW	Low Activity Waste
M	Molarity
N	Normality
PCT	Product Consistency Test
QA	Quality Assurance
QAPjP	Quality Assurance Project Plan for Testing Programs Generating Environmental Regulatory Data
QAPP	Quality Assurance Project Plan
QC	Quality Control
RPP	River Protection Project
RPP-WTP	River Protection Project-Waste Treatment Plant
SEM	Scanning Electron Microscope
SIPP	Semi Integrated Pilot Plant
SRNL	Savannah River National Laboratory
TCLP	Toxicity Characteristic Leach Procedure
VHT	Vapor Hydration Test
VSL	Vitreous State Laboratory
WTP	Waste Treatment and Immobilization Plant
XRF	X-Ray Fluorescence

SUMMARY OF TESTING

A) Objectives

The DM100 melter tests described in this report were designed to assess sulfate phase separation during the processing of glass formulations calculated from the LAW glass formulation algorithm when estimated process uncertainties are included in the worst-case direction. In particular, the principal objective of the tests was to provide data on the formation or lack of formation of a persistent and accumulating separate sulfate phase on the glass melt while processing various glass formulations in the alkali-limited region through the sulfate-limited region with decreasing alkali content. Additional objectives included determination of the effect of halides on secondary phase formation, determination of technetium retention in the glass product over a range of LAW glass compositions using rhenium as a surrogate, and generation of glasses for product quality testing for compositions that were not previously available. Completion of the test objectives is detailed in the following table:

Test Objective	Objective Met?	Discussion Section
Confirm that, in the alkali-limited region where waste loading is determined by sodium or sodium plus potassium content, sulfate phase accumulation does not occur across that range of sodium and potassium combinations.	Yes	Sections 3.0 and 4.2 provide visual observations and corroborative chemical analysis demonstrating the lack of secondary sulfate phase accumulation across the range of sodium and potassium combinations tested.
Demonstrate that, in the region where sulfate phase accumulation can limit waste loading, the proposed glass formulation correlation yields glasses without sulfate phase accumulation.	Yes	Sections 3.0 and 4.2 provide visual observations and corroborative chemical analysis demonstrating the lack of secondary sulfate phase accumulation across the range of sodium and sulfur concentrations tested.
Determine the effect of chlorine and fluorine on sulfate phase accumulation.	Yes	Sections 3.0 and 4.2 provide visual observations and corroborative chemical analysis demonstrating that secondary sulfate phase accumulation did occur in tests with higher concentrations of chlorine and fluorine in the feed.

B) Test Exceptions

WTP Test Exception, 24590-LAW-TEF-RT-05-00002, K. Abel, River Protection Project, Waste Treatment Plant, 3000 George Washington Way, Richland, WA 99352, 3/31/05.

C) Results and Performance Against Objectives

A series of six tests were conducted on the DM100-WV melter using a range of LAW Sub-Envelope simulants and corresponding melter feeds that produced glasses in the alkali-limited region through the sulfate-limited LAW glass composition region with varying alkali content. In addition, in all of the seven glass compositions that were used, the impact of higher levels of chlorine and fluorine on sulfate phase formation was also investigated. Rhenium as a surrogate for technetium was added to the feed in all tests to provide data on retention in the glass product, and the relative proportions of particulate and gaseous fractions in the melter exhaust. The results showed that each glass composition and transitions between glass compositions occurred without the formation of a separate sulfate phase on the melt pool surface. Conversely, separate sulfate phases were observed in most of the tests processing the same glass compositions containing high concentrations of halides. Separated sulfate phases were removed by bubbling the melt pool prior to continuing testing. Sulfate phases were identified by visual observations of multiple dip samples. Visual results were confirmed by chemical and microstructural analysis, which indicated the material was composed of two principal phases: an alkali and calcium sulfate phase with lesser amounts of chlorine, chromium, and rhenium in addition to a phase of radiating crystals composed of alkali sulfate, chlorine, and chromium. No difficulties were encountered in maintaining nominal operating conditions (glass temperature of 1150°C and a near complete cold cap while processing glass at 2000 kg/m²/day) in any of the tests.

Analysis of the feed samples and product glasses confirmed the composition of the feed and showed the intended transitions between the various compositions. Product glasses were selected to permit direct comparisons with the corresponding crucible melt results at high potassium and high sodium, moderate sodium, and low sodium levels, as well as to assess the effects of the increased halide levels on glass properties. All of the measured properties of the crucible and melter glasses are within acceptable limits for processing and product quality.

During the present tests, total particulate carry-over from the melter ranged from a quarter percent to over two percent and increased with increasing sodium, potassium, and halide feed content. Melter DFs were determined for most of the elements in the feed for each unique glass composition. The most volatile species were rhenium, halogens, and sulfur. Good mass balance closure was obtained for halides, sulfur, and rhenium for most of the test segments. Sulfur retention in the glass typically ranged from 75 - 95% and increased with increased feed sodium content and decreased with feed halide content. Chlorine, fluorine, and rhenium retention in the glass was typically 50 - 60%, 65 - 75%, and 20 - 40%, respectively, with no obvious relationship to concentrations of the other feed constituents. Rhenium melter emissions were entirely particulate, whereas chlorine, fluorine, and sulfur melter emissions were both particulate and gaseous. Consistent with previous tests conducted at 0.5 stoichiometric carbon ratio, approximately half of the feed nitrogen oxides were emitted as NO and NO₂ gases. Byproducts of incomplete combustion, such as carbon monoxide and ammonia increased with the amounts of carbon and nitrogen oxides in the feed.

D) Quality Requirements

This work was conducted under a quality assurance program based on NQA-1 (1989) and NQA-2a (1990) Part 2.7 that is in place at the VSL. This program is supplemented by a VSL Quality Assurance Project Plan (QAPP) for RPP-WTP work. Test and procedure requirements by which the testing activities are planned and controlled are also defined in this plan. The program is supported by VSL standard operating procedures that were used for this work. This work was not subject to DOE/RW-0333P or the WTP QAPjP for environmental regulatory data.

E) R&T Test Conditions

Melter tests were conducted using the DM100-WV melter, which has a melt surface area of 0.108 m². The DM100-WV is a continuously fed, ceramic refractory-lined melter equipped with a lance bubbler for glass pool agitation. The glass-melt is joule-heated using a pair of opposing Inconel electrodes. Feed is introduced into the melter by a peristaltic pump to ensure consistent feeding. For operational simplicity the melter is equipped with a dry off-gas treatment system involving gas filtration operations only.

Sufficient LAW feed, based on the compositions of various waste streams, was procured to conduct 800 hours of DM100 testing. The target processing rate of 2000 kg glass /m²/day was maintained throughout the tests. Multiple dip samples were collected from the melt pool at the end and during the transition from each glass composition to determine whether a separate sulfate phase had formed on the melt surface. Glass samples were analyzed for composition to calculate elemental mass balances.

Melter emissions data were collected during the steady-state portions of the tests. The melter exhaust was sampled for metals/anions/particles according to 40-CFR-60 Methods 3, 5, 26, and 29. Particulate collection required isokinetic sampling. Melter emissions were monitored for a variety of gaseous components, notably CO and nitrogen species, by Fourier Transform Infra-Red Spectroscopy (FTIR). Feed samples and melter glass samples (both discharged glass samples and dip samples) were analyzed for their chemical composition. Rheological properties of the feed samples were measured.

F) Simulant Use

The LAW waste simulants for the DM100 melter tests are based on the composition data provided in the WTP Test Specification 24590-LAW-TSP-RT-02-012, Rev. 0. and Test Exception 24590-LAW-TEF-RT-05-00002. The waste simulant compositions are based on the compositions of LAW tanks AP-101, AN-105, AN-107, AN-104, AN-102, AZ-101, and AZ-102. The concentrations of Cl, Cr, F, Ni, Pb, and P in the waste simulants were modified so that their target concentrations total half a weight percent in the glass product. All tests were conducted with the nominal halide concentrations, and also with Cl and F concentrations of 1.1 wt% and 1.3 wt% on a glass basis, respectively. The concentrations of potassium and sulfate

in the simulants also were modified to achieve the required K_2O and SO_3 concentrations in the respective glass compositions.

G) Issues and Follow-On Tests

The results from these tests demonstrate that glass formulations generated by the LAW glass formulation algorithm (including process uncertainties in the worst-case direction) which span a wide range of sodium and sulfate concentrations can be processed without forming separate sulfur phases on the melt surface. However, the results also indicate that separate sulfur phases are likely to form on the melt pool surface if the same feeds contain high halide concentrations. Chemical analysis of this separated material indicates that rhenium, which was used as a surrogate for radioactive technetium, is sequestered into the soluble secondary phase. In the limited number of previous tests with LAW feeds containing high chlorine concentrations, the formation of separated secondary phases was not observed and, therefore, high chlorine concentrations do not appear to be the only determining factor for the formation of secondary phases on the melt pool surface. Consequently, it is recommended that further testing be performed to better understand the relationship between chlorine and fluorine concentrations and the formation of secondary sulfate phases, and to define acceptable limits. It is recommended that this work should include isolating the effect of each of the two halides, defining halide concentration thresholds for secondary phase formation, and processing glasses with high concentrations of halides that in past studies with nominal halide concentrations did not result in secondary sulfate phases. The results of these tests should then be incorporated into a revision of the LAW glass formulation algorithm. It is worth noting that some additional DM100 melter testing is already planned for FY07.

SECTION 1.0 INTRODUCTION

Acceptable glass formulations for vitrification of Hanford LAW waste streams must meet a variety of product quality, processability, and waste loading requirements. To this end, a number of formulations were investigated during Part A [1], Part B1 [2] and Part B2 [3, 4] of the WTP development program. The testing resulted in the selection of target glass compositions for the processing of eight of the Phase I LAW tank wastes. The selected glass compositions were tested at the crucible scale to confirm their compliance with ILAW performance requirements. DM100 [5-16] and LAW Pilot Melter [17-28] tests were then conducted to demonstrate the viability of these glass compositions for LAW waste vitrification at high processing rates.

Glass formulation development work has been based on Hanford tank waste composition data [29-32] that have evolved over time. As a result, the target glass compositions for waste processing also have been adjusted to accommodate the changes in LAW waste compositions. The major components of interest in the LAW waste streams, from a waste loading perspective, are sodium, sulfur, and to a lesser extent potassium. Although schedule constraints associated with selection of glass compositions for melter testing did not always allow for extensive optimization of glass compositions as the waste composition data and WTP flow-sheet evolved, a range of acceptable glass formulations was selected for melter testing that met waste loading, melter processing, and ILAW performance requirements. Melter testing included composition variations involving the nominal feed and $\pm 15\%$ variations in the amount of waste simulant added to the melter feed. As a result of these efforts, the WTP Project now has a series of glass compositions with different sodium, potassium, and sulfur concentrations that have been tested and validated over a range of melter scales, including the LAW Pilot Melter.

Results from glass formulation and melter testing have been analyzed to develop a glass formulation algorithm for WTP LAW glasses [33]. Given the composition of an LAW stream, the algorithm permits the calculation of a suitable glass composition and the required glass forming additives such that all processing, waste loading, and product quality requirements would be met. Such an algorithm has obvious value for the operation of the WTP LAW vitrification facility. Reference [33] provides recommendations for testing and confirmation of the proposed algorithm based on a set of glass compositions generated by the algorithm. The recommendations also include an assessment of the effects of process control uncertainties (in terms of composition variations) expected for the LAW vitrification process followed by crucible and melter testing to ensure that acceptable glass properties and processing behavior are maintained when likely process control uncertainties are included. Subsequently, WTP R&T provided expected standard deviations for Na₂O and SO₃ concentrations based on process variations and analytical errors [34]. Based on that information, VSL/Duratek developed and recommended a series of test glass compositions and a series of DM100 melter tests ("Recommendations for Testing to Support LAW Glass Composition Correlation," VSL, 9/13/04) that were incorporated into a WTP Test Specification [35]. In response, a VSL Test Plan [36] was issued which details melter testing at the DM100 scale to provide the data required

to underpin the proposed algorithm. The data from the testing also serve to strengthen the correlation algorithm by producing LAW glasses that extend from the alkali-limited region through the sulfate-limited region with decreasing alkali contents.

Thus, the DM100 melter tests described in this report were designed to assess sulfate phase separation during the processing of glass formulations calculated from the LAW glass formulation algorithm when estimated process uncertainties are included in the worst-case direction. The DM100 melter testing is required since reliable information on sulfate incorporation and secondary phase accumulation in the dynamic melter environment cannot be obtained using laboratory crucible melts alone. Sulfate incorporation during real-time feed processing in an actual melter depends both on thermodynamic and kinetic factors. Crucible melts can provide information on saturation sulfate solubility, but are limited in their ability for assessing the practical effects of kinetic factors. Crucible melt testing to support the development of the correlation algorithm is being performed separately and therefore is not included in this report, which focuses on the results of melter testing.

1.1 Test Objectives

The principal objective of the DM100 tests was to provide data on the formation or lack of formation of a persistent and accumulating separate sulfate phase on the glass melt while processing various glass formulations in the alkali-limited region through the sulfate-limited region [33] with decreasing alkali content. The DM100-WV unit was selected for these tests. This melter platform was used for all of the initial LAW Envelopes A, B, and C tests [5-16] to demonstrate feasibility for the subsequent tests on the larger Pilot Melter [17-28]. The same melter was selected for the present tests in order to maintain comparisons between the data sets. Sufficient LAW feed was procured for this work to conduct 800 hours of DM100 testing with seven different glass compositions. In addition, transitions between the various compositions were also tested.

Per the WTP Test Specification for this work [35], the major objectives of these tests were to:

- Confirm that, in the alkali-limited region where waste loading is determined by sodium or sodium plus potassium content, sulfate phase accumulation does not occur across that range of sodium and potassium combinations.
- Demonstrate that, in the region where sulfate phase accumulation can limit waste loading, the proposed glass formulation correlation yields glasses without sulfate phase accumulation.
- Determine the effect of chlorine and fluorine on sulfate phase accumulation.

1.2 Quality Assurance

This work was conducted under a quality assurance program based on NQA-1 (1989) and NQA-2a (1990) Part 2.7 that is in place at the VSL. This program is supplemented by a VSL Quality Assurance Project Plan (QAPP) for RPP-WTP work [37]. Test and procedure requirements by which the testing activities are planned and controlled are also defined in this plan. The program is supported by VSL standard operating procedures that were used for this work [38].

This work did not generate data to support waste form qualification activities; nor did it generate environmental regulatory data, or data to support permitting activities. This work is not subject to DOE/RW-0333P or the WTP QAPjP [39] for environmental regulatory data.

1.3 Melter System Description

1.3.1 Feed System

A schematic diagram of the DM100 vitrification system is shown in Figure 1.1. The melter feed is introduced in batches into a feed container that is mounted on a load cell for weight monitoring. The feed is stirred with a variable speed mixer and constantly recirculated except for periodic, momentary interruptions during which the weight is recorded. The recirculation loop extends to the top of the melter where feed is diverted from the recirculation loop through a peristaltic pump and into the melter through a Teflon-lined feed line and vertical water-cooled feed tube. The use of a peristaltic pump in place of the usual simulated ADS pump was requested by WTP R&T for these tests because of the ability to reduce feed rate variations.

1.3.2 Melter System

Cross-sectional diagrams through the DM100-WV melter are shown in Figures 1.2a-c. The DM100-WV unit is a ceramic refractory-lined melter fitted with a pair of opposing Inconel 690 plate electrodes as well as a bottom electrode. The melter can be operated with either three-phase or single-phase power. However, the standard mode of operation, which was used for these tests, is single-phase with voltage applied to the side electrodes only. The bubbler used for stirring the melt pool enters from the top and is removable. The glass product is removed from the melter by means of an air-lift discharge system. The DM100-WV has a melt surface of 12 × 14 inches, giving a melt surface area of 0.108 m². The nominal depth of the melt pool is about 19 inches, which gives a typical glass inventory of between 115 and 120 kg. The plenum height is 27.5 inches. Temperatures are monitored by means of a series of thermocouples located in the melt pool, the electrodes, the plenum space, and the discharge chamber.

1.3.3 Off-Gas System

For operational simplicity, the DM100-WV is equipped with a dry off-gas treatment system involving gas filtration operations only. Exhaust gases leave the melter plenum through a film cooler device that minimizes the formation of solid deposits. The film-cooler air has constant flow rate and its temperature is thermostatically controlled. Consequently, under steady-state operating conditions, the exhaust gases passing through the transition line (between the melter and the first filtration device) can be sampled at constant temperature and airflow rate. The geometry of the transition line conforms to the requirements of the 40-CFR-60 air sampling techniques. Immediately downstream of the transition line are cyclonic filters followed by conventional pre-filters and HEPA filters. The temperature of the cyclonic filters is maintained above 150°C while the temperatures in the HEPAs are kept sufficiently high to prevent moisture condensation. The entire train of gas filtration operations is duplicated and each train is used alternately. An induced draft fan completes the system.

SECTION 2.0

WASTE SIMULANT AND GLASS FORMULATIONS

The DM100 melter tests described in this report were designed to assess sulfate phase separation during the processing of glass formulations calculated from the LAW glass formulation algorithm [33] when estimated process uncertainties are included in the worst-case direction. The compositions of the glasses selected for DM100 melter testing [35] and the order in which they were processed are given in Tables 2.1 and 2.2, respectively.

2.1 Waste Simulants

The LAW waste simulants for the DM100 melter tests are based on the composition data provided in the WTP Test Specification [32] and Test Exception [40]. The concentrations of Cl, Cr, F, Ni, Pb, and P in the waste simulants were modified so that their target concentrations in the glass equal the “others” concentrations given in Table 2.3. The concentrations of potassium and sulfate in the simulants also were modified to achieve the K_2O and SO_3 concentrations in the respective glass compositions. The potassium concentration in the LAWE4H simulant for Test 1 was set to zero so that the effect of potassium could be studied during the transition from LAWE3 to LAWE4H. The waste simulant compositions for LAWE3, LAWE4H, LAWE5H, LAWE6H, LAWE7H, LAWE9H, and LAWE10H are given in Tables 2.4-2.10. These compositions are based on the compositions of LAW tanks AP-101, AN-105, AN-107, AN-104, AN-102, AZ-101, and AZ-102. For Tests 1-3, the Cl and F concentrations were 0.20 wt% and 0.08 wt%, respectively. For Tests 4-6, the Cl and F concentrations were 1.1 wt% and 1.3 wt%, respectively. The halides were added as the respective sodium salts with a corresponding decrease in the sodium from other sources so that the target Na_2O concentrations in the glass compositions were maintained at the values given in Table 2.1, prior to renormalization for the added halides.

The simulant concentrations for feed processing in terms of the sodium molarity are given in Tables 2.4-2.10. The feed concentrations were estimated based on the waste loading and results from previous testing of melter feeds [41, 42]. In some cases, these concentrations are substantially different from feed concentrations that have been used previously in melter testing. For example, the waste loading for LAWE9H is 11.34 wt% and, based on this waste loading, the projected feed concentration is 4 molar sodium. The closest waste loadings that have been used previously in melter tests are about 7 wt% and 14 wt%, while the closest feed concentrations are 2.75 and 5.0 molar sodium.

2.2 Glass Formulation

The compositions of the glasses used for melter testing are given in Tables 2.1 and 2.3. The glass compositions along with the waste loadings and contributions from the waste

simulants and glass former additives are given in Tables 2.11-2.17. Crucible melts of glasses LAWE3, LAWE4H, LAWE5H, LAWE7H, LAWE9H, and LAWE10H were prepared and tested at VSL for compliance with processing and product quality requirements. LAWE6H was not prepared because it is sufficiently close to another glass composition that has already been characterized. The results of the tests confirmed that all of the glasses meet all the processing and product quality requirements.

Glass former additives [43] (for one liter each of the waste simulants) and the measured feed properties are given for crucible batch feed samples in Table 2.18. These are based on the concentrations of the waste simulants given in Tables 2.4-2.10. The feed produced in crucible size batches had the benefit of rigorous density determination and therefore the sodium molarities exactly matched the desired targets. The feed recipes provided to Optima were based on estimated densities and therefore the sodium molarities sometimes vary slightly from target. This difference also results in melter feed and crucible batch preparations having slightly different glass yields although the product glass compositions are the same. In each case, feed was prepared on the crucible scale, characterized and verified to be within the WTP specified rheology bounds [44], prior to melter tests. Based on the results of these measurements, additional water was added to LAWE10H to provide a feed within the prescribed rheological boundaries. Samples of all of the melter feeds were prepared and characterized before their use in the respective melter tests. The highest tested feed concentrations with rheological properties within the WTP bounds were selected for melter testing.

2.3 Sugar Additions

With high nitrate feeds, the addition of reductants is necessary in order to control melt foaming. Sugar, which was used for this purpose at West Valley, has also been selected as the baseline reductant for the WTP. The amount of sugar required increases with the amount of nitrates present in the feed and decreases with the amount of waste organics present in the feed, which themselves act as reductants. Excessive additions of reductants can be deleterious, leading to over-reduction of the melt and formation of sulfides and molten metals. Consequently, the oxidants and reductants in the feed must be suitably balanced. The basis for achieving this balance was developed by VSL and Duratek for the vitrification of high-sodium-nitrate feeds at Savannah River's M-Area and has been successfully applied to the processing of a wide variety of simulated RPP-WTP feeds over the past eight years. In developing this approach, we elected to conservatively adopt the most reducing potential reaction as the basis for the *definition* of a "sugar ratio" of 1.0 as a result of concerns for over-reducing the melt. Such a reaction, using sodium salts as an example, is:

Fundamentally, the basis that is selected is simply a convention, since the precise stoichiometry of the reactions involved is neither known nor constant under the conditions prevailing in the melter. However, with this convention, a sugar ratio of 1.0 corresponds to one mole of sucrose per eight moles of nitrate or, more generally, 1.5 moles of organic carbon per mole of nitrate. It is then expected that significantly less sugar than this will be required in practice. The

empirically determined amount required to successfully control melt foaming without significantly reducing the glass melt was found to correspond to a ratio of 0.5 when any nitrites present were counted as nitrates (i.e., 0.75 moles of organic carbon per mole of nitrate + nitrite). This approach has been employed for all WTP melter testing. It is, however, expected that slight variations around the nominal value of 0.5 may be necessary to account for differences in the reducing power of waste organics in comparison to sugar, particularly for LAW streams that are high in organics.

The calculation of the amount of sugar needed to achieve a stoichiometric sugar ratio of 0.5 for Test 1A (LAW E3) proceeds as follows:

- One liter of simulant contains 183067 mg nitrate and 58110 mg nitrite (see Table 2.4) which corresponds to 2.953 moles of nitrate and 1.263 moles of nitrite, giving a total of 4.216 moles of NO_x
- Required total amount of organic carbon for a sugar ratio of 0.5 is $4.216 \times 0.75 = 3.162$ moles
- One liter of simulant contains 2718 mg or 0.227 moles of organic carbon (see Table 2.4)
- Therefore, $3.162 - 0.227 = 2.935$ moles of organic carbon must be added.
- The molecular weight of sucrose is 342 g per mole, $2.935 \times 342/12 = 83.65$ g sugar must be added per liter of simulant, as shown in Table 2.18.

2.4 Preparation of Melter Feed

Optima Chemicals, which has supplied all of the LAW simulants for the previous DM100 and LAW Pilot Melter studies, provided the required amounts of the various feed blends to conduct all the tests shown in Table 2.2. The LAW feed from Optima was received at VSL complete except for sugar, a small portion of the sodium in the target composition, potassium in the LAWE4H formulation, the additional chlorine and fluorine to increase the target glass concentrations to 1.1 and 1.3 wt% respectively in Tests 4-6, the rhenium spike, and a small portion of the feed water. Sugar was added to the feed at a stoichiometric ratio of 0.5 in the manner described in Section 2.3. The amount of sodium left out of the feed by Optima corresponded to the amount of sodium in the NaF and NaCl added to the feed in Tests 4-6 to achieve target glass concentrations of the halides and sodium. Adjustments made to the feed to accommodate the additional sodium halides are shown in Table 2.19. The majority of the sodium that was removed was in the form of sodium hydroxide. However in tests with the LAWE9H composition, sodium carbonate was removed to account for the sodium, and in tests with the LAWE10H composition, sodium carbonate and nitrate were removed. In Tests 1-3, sodium was added as a 50% sodium hydroxide solution to the feed to bring the sodium feed content to the target concentration. Additions of the halides to the target glass compositions in Tests 4-6 reduced the concentration of the other constituents in the target composition by a total of 2.12 wt% after renormalization. The addition of halides to the feed had little effect on the properties of the feed as shown by comparison of the measured feed properties of crucible batches given in Tables 2.18 and 2.19 for feeds with low and high halide concentrations, respectively. Elements with the highest concentrations in the target composition, such as silicon

and sodium, are reduced by the largest absolute amounts. The potassium oxide target of 0.54 wt% in Tests 1A and 6B was achieved by adding potassium hydroxide to the feed. This addition resulted in a slight decrease in the concentrations of the other constituents in proportion to their feed concentrations. This was partially mitigated by the addition of sodium hydroxide to maintain the original sodium concentration, as shown in Table 2.12. A WTP Test Exception [40] was issued to specify the addition of rhenium (as a technetium surrogate) to the feed in all of the tests in order to track its fate in the process. The rhenium was added in the form of perrhenic acid to achieve a concentration of 0.1 wt% as rhenium oxide assuming total retention in the glass product. The rhenium spike, as with the halides, reduces the concentrations of the other constituents in proportion to their concentration.

2.5 Analysis of Feed Samples

2.5.1 General Properties

Feed samples from each test were analyzed to confirm physical properties and chemical composition. Samples were taken during melter testing from an inline sampling port in the feed line. Sample names and sampling dates are listed, and measured properties are compared to target in Table 2.20. Target values were obtained by measurements on crucible batch samples and, for glass yield (kg/kg), by calculation from the recipe. Measured water content, density, glass yield, and pH were similar for all samples from the same test, and were consistent with the target values. One exception is the pH for samples from Tests 2C through 3C, where the melter feed samples have pH values from 0.5 to 2.2 higher than the values measured on the crucible batch samples. This difference may be a result of absorption of atmospheric carbon dioxide, which can vary depending on the time at which the final amount of sodium hydroxide was added, the length of time the sample was mixed, and the time lapse before the pH is measured. The highest pH values were measured in tests using waste that contained the highest concentration of hydroxide, such as in Tests 1A and 1B. For this reason, pH values were lower in tests with added sodium halides than comparable tests with sodium added mostly as sodium hydroxide. Small decreases in glass yield were observed due to the incorporation of reductants in the melter feed, which do not produce glass; crucible batch samples had no added reductants and therefore had higher glass yields. Also, small amounts of water are added during the transfer of melter feed, which reduces glass yields. Despite the addition of sugar and water to the melter feed, measured glass yields were within seven and a half percent of the target, validating the use of target glass yields (kg/kg) for glass production rates.

2.5.2 Rheology

Samples of the melter feeds that were used for these tests were also subjected to rheological characterization. The results from rheological characterization of a variety of other melter feeds and waste simulants, as well as the effects of a range of test variables, are described in detail in a separate report [41]. Melter feeds were characterized using a Haake RS75 rheometer, which was equipped with either a Z40DIN or a FL22-SZ40 sensor. A typical set of measurements consists of identifying the flow characteristics of the slurry by measuring the shear stress on the slurry at controlled shear rates and temperatures. In these measurements, the

shear rate values are preset and are increased stepwise from 0.01 s^{-1} to 200 s^{-1} (70 s^{-1} for FL22-SZ40) with a sufficient delay (typically 15 to 30 seconds) between steps to ensure that shear stress is allowed to fully relax and therefore be measured at equilibrium. This approach is somewhat different from the "flow curve" approach in which the shear rate is ramped up to some maximum value and then ramped back down to produce a hysteresis curve that is dependent on the selected ramp rate. The viscosity of the sample as a function of the shear rate is then calculated as the ratio of the shear stress to the shear rate. The yield stress data for the melter feeds were measured using a controlled-stress mode in which the torque on the rotor was slowly increased while the resulting deformation of the fluid was monitored. The discontinuity in the measured deformation-torque curve was identified as the yield stress. It should be noted that this direct measurement of the yield stress can be quite different from the value obtained by extrapolation of the shear stress-shear rate curve to zero, the value often reported. All of the measurements in this work were made at 25°C ; previous work [41], which examined a range of temperatures, showed a relatively weak effect of temperature.

Rheograms for select melter feeds, which show the feed viscosity versus shear rate, are presented in Figures 2.1 and 2.2; measured values for viscosity at selected shear rates and the yield stress are shown in Table 2.21. Samples for rheological testing were selected at the extremes of feed sodium content and waste loading. An additional sample was tested to determine the effect of the added halides on rheological properties. Notice that melter feed with LAW Envelope B waste is considerably more viscous than the feed samples from LAW Envelope A waste. Higher viscosity in melter feed samples with LAW Envelope B wastes has also been observed in previous studies and is due to the addition of more glass forming additives and less of the aqueous waste, which results in a lower pH. Halide additions to the feed had no discernable effect on the rheological properties of the feed. The rheological properties of all three feed samples are well within the Project bounds [44]. The LAWE10H feed was brought within these limits by the dilution of the feed with additional water prior to the melter test (see Section 2.2). The yield stress values exhibited the same trends as those described for the viscosity at low shear rates.

2.5.3 Chemical Composition

The chemical compositions of the feed samples were determined by first making a glass from the feed via crucible melt. The glass was subsequently crushed and analyzed directly by X-Ray Fluorescence Spectroscopy (XRF). The boron oxide and lithium oxide target values were used for normalizing the XRF data since their concentrations were not determined by XRF. Data are compared to the target compositions in Table 2.22. Selected samples from the early tests were also subjected to DCP analysis of solutions generated by microwave aided acid dissolution; the results are compared to those obtained by XRF in Table 2.23. The XRF values reported for fluorine were generated using an analytical method which uses a polished solid monolith as opposed to the less than 200 mesh glass powders used for analysis of all other elements. The results generally corroborate the consistency of the feed composition and show good agreement with the target composition for the major components. Boron and lithium concentrations measured by DCP were within nine percent of the target, validating the use of the target value for normalizing the XRF data. Of the oxides with a target concentration of one percent or greater,

only the XRF values for magnesium, titanium, zinc, and zirconium oxides had deviations of greater than 10% from target. These deviations were also observed at about the same frequency and magnitude in the product glasses (see Section 4.1). Only two tests had feed samples with measured magnesium oxide deficits greater than 10%; the deficits for both these tests were less than 11%. Surpluses in titanium oxide and deficits in zinc oxide between 10 and 18.5 percent were measured in samples from about half the tests. Similar observations with respect to titanium were made in previous tests with LAW melter feeds [7-10, 12, 14] due to its presence as a contaminant in the glass forming additives. The DCP measured values for zinc deviated from their respective target values significantly less than did the corresponding values measured by XRF, suggesting a potential low analytical bias for zinc using the XRF for these samples. Only three tests had feed samples with measured zirconium oxide deficits greater than 10%; the deficits for both of these tests were less than 10.3%. Since a low bias for sodium is not uncommon for the DCP analysis, the sodium values generated by XRF are used in preference. Volatile minor elements such as sulfur, rhenium, and halides are, as expected, below target due to loss during crucible melting.

The target concentrations in the feed are verified from the simulant vendor's batching sheets. The additional amounts of chemicals added by the VSL are calculated, checked, and weighed out using calibrated balances.

SECTION 3.0 MELTER OPERATIONS

A series of six tests were conducted on the DM100-WV melter between 6/13/05 and 9/16/05. The tests used a range of LAW Sub-Envelope simulants and corresponding melter feeds which produced glasses in the alkali-limited region through the sulfate-limited LAW glass composition region with varying alkali content. In addition, in all of the seven glass compositions that were used, the impact of higher levels of chlorine and fluorine on sulfate phase formation was also investigated. These tests produced almost seven metric tons of glass from over fourteen metric tons of feed. Summaries for all the tests are provided in Table 3.1. The tests were divided as follows:

- Test 1: 100 hours, glass compositions LAWE3 and LAWE4H without K
- Test 2: 175 hours, glass compositions LAWE4H, LAWE5H, LAWE6H, and LAWE7H
- Test 3: 125 hours, glass compositions LAWE7H, LAWE9H, and LAWE10H
- Test 4: 115 hours, glass compositions LAWE10H, LAWE9H, and LAWE7H, all with Cl and F targeting 1.1 and 1.3 wt%, respectively, in the glass product assuming total retention
- Test 5: 175 hours, LAWE7H, LAWE6H, LAWE5H, and LAWE4H, all with Cl and F targeting 1.1 and 1.3 wt%, respectively, in the glass product assuming total retention
- Test 6: 100 hours, LAWE4H without K and LAWE3, both with Cl and F targeting 1.1 and 1.3 wt%, respectively, in the glass product assuming total retention.

A primary objective of these melter tests was to determine if secondary sulfur phases result from processing or transitioning between a variety of glass compositions generated by the LAW glass formulation algorithm [33]. This was achieved using a sampling and analysis protocol designed to differentiate between a pervasive sulfate layer and transient localized patches of sulfate. Dip sampling was performed while each new glass composition was processed (typically after four melter turnovers) and during the transition between glass compositions when the glass composition has transitioned approximately half way to the new glass composition (0.69 melter turnovers or about 9 hours processing at 2,000 kg/m²/day production rate). At each sampling event, feeding was interrupted and bubbling reduced while five dip samples were collected. The melt surface was considered free of a pervasive sulfate layer if at least four of the five samples had no visible secondary sulfate phases, in which case feeding of the melter was resumed. If only one of the five samples had visible secondary sulfate, it was considered transient (sulfate phase resulting from the consumption of the cold cap and/or the melting of salt deposits in the plenum and film cooler because radiant heat from the glass increases as the cold cap is consumed). If more than one of the five samples exhibited secondary sulfate, the cold cap was burned off entirely and the dip-sampling repeated. Inspection and analysis of the dip samples indicated that no secondary sulfate layers were present on the melt pool surface during any of the tests without the envelope maximum concentration of halides. Conversely, secondary layers were observed in the transitions and at the end of many of the tests in which the increased levels of halides were included in the feed. No specific pattern of sulfate layer formation with sulfur and sodium feed content was identified. The common compositional

factor in the formation of secondary phases was the presence of the additional halides. After a sulfate layer was detected on the melt surface, the glass pool was bubbled until the dip samples indicated that the sulfate layer had dissipated, prior to commencing the subsequent test segment. A detailed list of all the individual dip samples, including visual results and analysis, is provided in Section 4.2.

Attempts were made to replicate the melter configuration and operating conditions used for the corresponding tests conducted earlier and the previous LAW Sub-Envelope [5-16] tests. These conditions include a near complete cold cap, which is between 80-95% melt surface coverage for the DM100, since a 100% cold cap tends to lead to "bridging" in smaller melters. Cold cap conditions were similar to those experienced in previous DM100 tests with LAW simulants [5-16]. The target glass production rate of 2000 kg/m²/day was approximated for all tests, as depicted in Figures 3.1.a – 3.1.f. No significant processing problems were observed as a result of the intended compositional changes or additions of halides to the feed. During the second test, three feed interruptions of up to 65 minutes in duration occurred as a result of clogging of the feed line. The tubing from the peristaltic pump to the melter feed nozzle was therefore changed to a wider diameter tube and shielded from heat radiating from the melter lid. No significant interruptions were experienced due to feed system clogging after these changes were made. The instantaneous production rates varied by about 25%. The larger decreases in feed rate and gaps in the production rate curves shown in Figures 3.1.a – 3.1.f were the result of down-time for feed transfers, dip sampling, and in the case of Test 2, to change the tubing around the peristaltic pump.

Glass pool bubbling was adjusted over the course of all the tests to maintain the target production rate of 2000 kg/m²/day and, therefore, the bubbling rate used for each composition gives an indication of the relative rates the feed compositions can be processed. Bubbling rates used throughout the tests are shown in Figures 3.2.a – 3.2.f and average bubbling rates for each test segment are given in Table 3.2. During each test segment, bubbling rates were relatively constant except around feed interruptions for feed transfers and dip sampling events. Figure 3.3 shows the increase in the bubbling rate from about 7 lpm to over 20 lpm as the sodium content of feed increased over the course of testing. The increase in sodium concentration in these glass compositions coincides with increase in waste loading and therefore the higher bubbling rate could be in response to the lower proportion of glass forming additives in the feed. The same relationship of increasing ease of production with decreasing feed sodium content and waste loading was observed in tests on the LAW Pilot Melter [45]. Also apparent in Figure 3.3 is an up to two-fold decrease in bubbling required when the envelope maximum concentrations of halides are added to the feed. The increased ease of production with increased feed halide content observed with these LAW simulants was not observed in previous tests with HLW simulants [46], indicating that there are compositional effects on the production rate increases realizable through halide additions to the feed. Comparison of Test 1B with 2A and Test 5D with 6A permits an assessment of the effect of potassium on the bubbling rate needed to obtain the same glass production rate; the effect is small but in the direction of faster melting with potassium than without.

The results of various operational measurements that were made during these tests are given in Table 3.2. Glass temperatures are shown in Figures 3.4.a – 3.4.f, plenum temperatures in Figures 3.5.a – 3.5.f, electrode temperatures in Figure 3.6.a – 3.6.f, and melt pool resistance in Figure 3.7.a – 3.7.f; electrode power is included in Figures 3.5.a – 3.7.f. Test segment average bulk glass temperatures (1144-1155°C) approximated the target glass temperature of 1150°C. Glass temperatures near the top of the melt pool are not reliable indicators of bulk glass temperatures as a result of gradients near the cold cap. Plenum temperatures typically ranged from 525 to 600°C, within the 450 to 650°C target. This is deliberately somewhat higher than for the larger melters (DM1200 and LAW Pilot Melter) in order to reduce cold cap bridging that occurs in the smaller melters. Higher plenum temperatures occurred in Tests 4 - 6 during repeated dip sampling events and bubbling periods used to remove secondary phases from the melt surface, as can be observed in Figure 3.5.f at 50 hours run time. The east electrode temperatures averaged between 1125-1150°C; that electrode was about 50-75°C hotter than the west electrode and was about 225°C hotter than the bottom electrode, which was not powered during these tests. The difference in temperature between the side electrodes is probably due to extreme sensitivity of thermocouple placement in the electrodes and therefore not reflective of an overall temperature difference between the sides of the melter. Power supplied to the electrodes typically varied by only 1 kW from the average values for most of the testing; however, much larger changes were observed during dip sampling events and extended bubbling periods to rid the melt surface of secondary phases. As expected, melt pool resistance increased with decreasing sodium content of the glass, as illustrated in Figure 3.8. Unlike the bubbler flow required to achieve the target production, the glass resistance is unaffected by the higher halide concentrations in the feed.

The gas temperature at the film cooler was about 300°C and depended on the plenum temperature, the amount of added film cooler air, and the temperature of the added film cooler air. A small drop of ten to fifteen degrees in gas temperature was observed across the (insulated) transition line; the high temperature is maintained in order to prevent condensation in the downstream filtration units.

SECTION 4.0 GLASS PRODUCTS

Nearly seven metric tons of glass was produced in these tests. The glass was discharged from the melter periodically into 5-gallon carbon steel pails using an airlift system. The discharged product glass was sampled at the end of each test by removing sufficient glass from the top of the cans for total inorganic analysis. Product glass masses, discharge date, and analysis performed are given in Table 4.1. Sets of five glass samples were also obtained by dipping a rod into the glass pool during and at the end of each test. All of the "dip samples" underwent visual examination to detect the presence of a separate sulfate phase on the glass surface; select samples were also subjected to chemical and microstructural analysis to confirm the visual results.

4.1 Compositional Analysis of Discharged Glass

Discharge glass samples were crushed and analyzed directly by XRF. The target values for boron and lithium oxides, which are not determined by XRF, were used for normalizing the XRF data to 100 wt%. The XRF analyzed compositions of all discharged glass samples are provided in Table 4.2. The XRF values reported for fluorine were generated using an analytical method which uses a polished solid monolith as opposed to the less than 200 mesh glass powders used for analysis of all other elements. Selected samples from the early tests were also subjected to DCP analysis of solutions generated by microwave aided acid dissolution; the results are compared to those obtained by XRF in Table 4.3. The majority of the XRF analysis results compared very favorably to their corresponding target values and also corroborated the feed sample analyses (see Section 2.5.3). Of the oxides with a target concentration of one percent or greater (not including halides spiked into the feed in Tests 4-6), only the XRF values for magnesium, sodium, titanium, zinc, and zirconium oxides had deviations of greater than 10% from target. Only one test had samples with measured magnesium oxide deficits greater than 10%; the deficit for that test was less than 12%. Surpluses in titanium oxide and deficits in zinc oxide of between 10 and 20 percent were measured in samples from about half the tests. Similar observations with respect to titanium were made in previous tests with LAW melter feeds [7-10, 12, 14] due to its presence as a contaminant in the glass forming additives. The DCP measured values for zinc deviated from their respective target values significantly less than did the corresponding values measured by XRF, suggesting a potential low analytical bias for zinc using the XRF for these samples. Only two tests had samples with measured zirconium oxide deficits greater than 10%; the deficits for both these tests were less than 12.5%. Surpluses in sodium occurred in Tests 3C and 4A while processing feeds with the lowest sodium content, suggesting that the glass pool was not completely turned over with respect to this element. The absolute oxide deviations, for oxides with deviations greater than 10 relative percent, are relatively small and therefore would have no significant effect on glass properties. Values for all the major oxides analyzed by DCP compare favorably with the XRF analysis except for silicon and zinc. SiO_2 concentrations measured by DCP are frequently lower than those measured by XRF, but the deviations are less than 10% from the target. Chromium was significantly higher than the target value for both DCP and XRF analysis due to leaching of chromium from melter components

such as the refractories and Inconel. Volatile components, such as halides and rhenium, were depleted in the glass product, as expected. Rhenium values measured by XRF were on average 40% less than those measured by DCP, in contrast to a previous study which showed the methods providing comparable values [47]. Rhenium mass balances around the melter (glass + emissions) using the XRF glass values are between 82 and 114% (see Section 5.3), suggesting that the XRF values can be reliably used. Using DCP glass values for the rhenium balance would result in rhenium surpluses for each test and, therefore, these were not used for mass balance determinations. The DCP analysis results for boron and lithium are within eight percent of the target values, validating the use of the target boron and lithium concentrations for normalizing the XRF data.

Compositional trends for most oxides measured by XRF with target concentrations greater than one percent are illustrated in Figures 4.1 - 4.3. Sodium, silicon, calcium, and magnesium glass concentrations show the intended transition from a high-sodium composition to a low-sodium, high alkaline earth composition and then transition back to the high-sodium concentration. Potassium oxide concentrations are near the target of about five weight percent in the first and last test segments, drop dramatically in the second and second-to-last test segments due to the intentional omission from the feed; the values are constant throughout the rest of the tests at about half a weight percent. Many oxide concentrations remain constant throughout testing including aluminum, iron, titanium, and zinc, which are shown in Figure 4.2, as well as zirconium and boron.

Compositional trends for the volatile elements sulfur, chlorine, fluorine, and rhenium measured by XRF are compared to target concentrations in Figures 4.4-4.7. The sulfur contents of the glasses follow the inverse trend to soda. At the higher target concentrations of sulfur, which correspond to the lowest soda concentrations, a larger proportion of the sulfur is volatilized. This is in keeping with several previous melter tests which showed that sulfur retention in the product glass as a percent of feed is highest for the LAW Sub-Envelope A compositions and lowest for LAW Sub-Envelope B compositions [8, 10, 12, 45]. During the tests with additional halides, chlorine and fluorine reach steady-state concentrations in the glass product at about 55 and 75 percent of their target values, respectively. Chlorine retention in the product glass of between 50 and 60 percent of feed has been typically observed in LAW melter tests [8, 10, 12]. The test results also show that rhenium showed even greater volatility than the halides, with only between 20 and 40 percent remaining in the glass product. It is also evident from Figures 4.4-4.7 that further depletions of the volatile constituents in the glass occurred during the idling periods in between tests.

4.2 Glass Pool Samples

Glass dip samples were obtained primarily to ascertain whether a secondary sulfate layer had formed on the surface of the glass melt. A list of all dip samples taken including sample names, target glass volatile concentration (Cl, F, SO₃, ReO₂), sampling date, and visual observations, is given in Table 4.4. Samples were taken in groups of five by dipping metal rods into the melter and placing the rods with adhering glass into steel pails to cool. After about ten minutes, the glass was sufficiently cool to observe separated phases, if present, on the surface of

the glass as well as adhering to the threads of the metal rod. An example of cooled glass on the metal rods is shown in Figure 4.8 and a closer view of separated phases on one of the samples is shown in Figure 4.9. After the glass cooled and observations of secondary phases on the rod were noted, the glass was broken off the rod and placed in Petri dishes for closer examination, as shown in Figure 4.10. Pictures were taken of the glass in Petri dishes, including detailed pictures of secondary phases like those shown in Figure 4.11. It is important to note that much of the secondary phases strongly adhere to the rod, as shown in Figure 4.12, and therefore not all the secondary phases are preserved with the archived glass sample.

Visual observations of the dip samples indicated that secondary phases were not present on the melt surface during or at the end of any of the tests with nominal halide concentrations. In contrast, however, secondary phases were observed in most of the tests with envelope maximum halide concentrations. In three of the fifteen dip sampling events during the tests with nominal halide concentrations, small amounts of secondary phases were observed in one of five samples. Given the established testing criteria, these solitary samples with secondary phases represent localized, transient sulfate patches resulting from the consumption of the cold cap and/or the melting of salt deposits in the plenum and film cooler as radiant heat from the glass increases as the cold cap is consumed. In ten of the fifteen dip sampling events during the tests with envelope maximum halide concentrations, at least two of five dip samples had evidence of secondary phases. These secondary phases occurred at the end of seven of the nine test segments and at half of the transitions between glass formulations. In the vast majority of the dip sampling events that indicated the presence of a secondary phase, three to five of the dip samples had visible secondary phases. No pattern was observed within sets of five dip samples, such as the first or last samples being more or less likely to contain secondary phases. Most of the secondary phases were removed from the melt surface after about a half hour of bubbling; however, in two instances, significantly longer bubbling periods were required (both dip sample events around Test 4C).

Chemical and morphological analysis of the secondary phases was conducted on select samples by Scanning Electron Microscope (SEM) equipped with Energy Dispersive X-ray Spectroscopy (EDS). The first sample analyzed was also the first sample to indicate the presence of a secondary phase: WVZ-D-74C from Test 1B. The results of the analysis, depicted in Figures 4.13.a and 4.13.b, indicate that the secondary phases are composed of alkali halides and alkali perhenates with no sulfur species. Another sample with visible secondary phases, AWW-D-147A from Test 3B, had similar secondary phases although no fluorine was observed and sulfate was present. It is important to note that for both of these samples, only a very small amount of material was available for analysis which may bias the results. Conversely, samples taken from tests conducted using feed enriched with halides produced more than sufficient amounts of secondary phase material for analysis. A typical example is shown in Figures 4.14.a – 4.14.c. The analysis reveals two distinct phases: a substrate consisting mainly of calcium and alkali sulfate with lesser amounts of chromium, chlorine, and rhenium, and crystals radiating out from the substrate consisting of alkali sulfate with lesser amounts of chromium and chlorine. The analysis indicating the presence of a phase containing calcium sulfate confirm observations of an insoluble component in the secondary phase that could not easily be washed from the sampling rods with water.

Additional verification of the presence and composition of secondary phases was provided by a glass washing procedure. Two hundred and fifty milligrams of ground glass from select samples was placed in a bottle with two hundred and fifty milliliters of de-ionized water, agitated, and set aside until the particles settled to the bottom of the container. Subsequently, enough of the supernatant solution was removed for anion chromatography to measure sulfate, chloride, and fluoride concentrations, as well as for DCP to measure rhenium. The results of this procedure for the samples tested are compared to the respective targets in the glass product, and the visual observations of secondary phases, in Table 4.5. Also included are the results of this procedure performed on several glasses produced in previous tests [48-50], which did not contain halides, sulfur, or rhenium to provide estimates of background concentrations for each element. Based on analysis of these samples, concentrations of at least 1 ppm F, 23 ppm Cl, 2.1 ppm sulfate, and 0.5 ppm Re (2 X “blank” concentration) are required as an indication of soluble secondary phases. Other additional samples included in Table 4.5 are samples taken after idling periods which have definitive secondary phases, and off-gas particulate material removed from the cyclones which are known to be enriched in volatile feed components. Measured concentrations of sulfate, and halides in the cyclone solids sample, are much higher than the background indicating that the method can easily distinguish between samples with and without soluble secondary phases. The measured concentrations for the dip samples support the field observations of secondary phases and are also consistent with the results obtained from subsequent SEM-EDS analysis. Samples in which no secondary phases were observed in the field seldom have concentrations above the blank thresholds, whereas samples with visually observed secondary phases usually have at least one measured concentration above the blank values. It is important to note that often, much of the observed secondary phase remains on the rod, and therefore not all solutions generated from samples taken where secondary phases were observed should be expected to have high solution concentrations. Also, portions of the secondary phases are insoluble and therefore will not release anions into solution. Another point of interest is the amount of rhenium in many of the wash solutions. Rhenium was used as a surrogate for radioactive technetium present in the actual waste.

4.3 Glass Property Testing

Glass property measurements, including product quality testing, were performed on five glasses taken from the end of five selected test segments, as specified in the Test Specification [35]. These selections permit direct comparisons with the corresponding crucible melt results at high potassium and high sodium, moderate sodium, and low sodium levels; in addition, they permit an assessment of the effects of the increased halide levels on glass properties. In Figures 4.15 – 4.19, the melter glass data are compared to the corresponding data collected in crucible-scale glass formulation studies for melt viscosity, melt electrical conductivity, sodium and boron Product Consistency Test (PCT; ASTM C 1285) leach rates, Vapor Hydration Test (VHT) alteration rate, and zinc concentrations in Toxicity Characteristic Leach Procedure (TCLP) leachates (SW-846 Method 1311). The data are also presented in tabular form in Table 4.6 for viscosity and electrical conductivity, Table 4.7 for PCT and VHT, and Table 4.8 for TCLP. All of the measured properties of the crucible and melter glasses are within acceptable limits for processing and product quality. The viscosities and electrical conductivities of the crucible and melter glasses are similar and the higher halide concentrations do not show any

noticeable effect. PCT releases for the high alkali (18.21 wt% Na₂O and 4.98 wt% K₂O) LAWE3 crucible and melter glasses are similar at the low halide concentrations, but show substantially higher B and Na releases for the melter glass sample with higher halide concentration. In contrast, PCT releases of the lower alkali, LAWE7 and LAWE10 crucible and melter glasses are similar, with no significant effect of higher halide concentrations. VHT alteration rates for the crucible and melter glasses are similar, with the differences within the normally large variations inherent in the VHT test results. Zinc concentrations in TCLP leachates for the LAWE7 and LAWE10 crucible and melter glasses are similar, with no noticeable effect of higher halide concentrations. TCLP results for the LAWE3 crucible and melter glasses, however, show higher Zn concentration in the TCLP leachate for the melter glass with higher halide concentration, as compared to the corresponding melter glass with lower halide concentration and the crucible glass. The analyzed composition of the LAWE3 melter glass with higher halide concentration, DWV-G-51B (see Table 4.2), does not show any deviation that would explain the higher PCT and TCLP leach rates. Based on these observations, it seems likely that the PCT and TCLP leach rates of glasses with high alkali concentrations increase as their Cl and F concentrations are increased.

Samples of the as-melted and heat treated crucible and melter glasses were examined for the presence of secondary phases. Glass samples were heat treated at 850°C for 20 hours, and according to the canister centerline cooling (CCC) curve [51]. Observations of the as-melted and heat treated samples are given in Table 4.9. The majority of the as-melted glass samples appeared clear and green in color. Traces of secondary sulfate phases were observed on melter discharge samples from tests with high Cl and F. All of the heat treated glasses, except for LAWE10H samples, appeared clear and green in color, without the presence of any secondary phases. Heat treated crucible and melter samples of LAWE10H showed small amounts (0.1 to 0.6 vol%) of augite crystals, mostly at the crucible contact surface.

SECTION 5.0

MONITORED OFF-GAS EMISSIONS

5.1 Particulate Sampling

The melter exhaust was sampled for metals/particles/acid gases according to 40-CFR-60 Methods 3, 5, 26, and 29 at steady-state operating conditions during each test segment. The concentrations of off-gas species that are present as particulates and gaseous species that are collected in impinger solutions were derived from laboratory data on solutions extracted from air samples (filters and various solutions) together with measurements of the volume of air sampled. Particulate collection required isokinetic sampling, which entails removing gas from the exhaust at the same velocity that the air is flowing in the duct (40-CFR-60, Methods 1-5). Typically, a sample size of 30 dscf was taken at a rate of between 0.5 and 0.75 dscfm. Total particulate loading was determined by combining gravimetric analysis of the standard particle filter and chemical analysis of probe rinse solutions. An additional impinger containing 2 N NaOH was added to the sampling train to ensure complete scrubbing of all acid gases and to distinguish between halogens in the form of acids or homonuclear molecular gases. The collected materials were analyzed using direct current plasma atomic emission spectroscopy (DCP-AES) for the majority of the constituents and ion chromatography (IC) for anions. Melter emission fluxes are compared to feed fluxes in Table 5.1. Notice the distinction that is made between constituents sampled as particles and as "gas". The "gaseous" constituents are operationally defined as those species that are scrubbed in the impinger solutions after the air stream has passed through a 0.3 μm heated filter. All samples are well within the 90 – 110% limits for isokinetic sampling.

Solids carry-over from the melter ranged over about an order of magnitude, from a quarter percent to over two percent of feed solids, depending on feed sodium and halide content. This trend is illustrated in Figure 5.1, which depicts particulate melter emissions as a function of feed sodium content. Notice for each composition, the fifty to one hundred percent increase in particle emissions in tests with higher halide concentrations in the feed. The apparent decrease in emissions at the highest sodium concentrations resulted from omitting potassium in the feed during Tests 1B and 6A as well as the potassium oxide concentration in Tests 1A and 6B being an order of magnitude higher than for any other test; potassium is more volatile than sodium and hence contributes more to particle emissions relative to its concentration in the feed. The relationship between feed sodium content with sodium, rhenium, chlorine, fluorine, and sulfur emissions is illustrated in Figures 5.2 – 5.6, respectively. As expected, sodium emissions increase with increasing feed sodium content and also increase by a factor of two at the higher halide feed concentrations. Rhenium emissions appear to increase with feed sodium content in the lower sodium concentration range but are unaffected in the higher sodium range. Although rhenium emissions were mostly higher in tests with the halides added to the feed, the effect was significantly less than for sodium. Halide emissions increase with increasing feed concentration but are unaffected by the other feed constituents, including sodium. Sulfur retention in the glass was inversely proportional to the sodium content of the target glass; however, it should be noted that in these tests, the feed sulfur varies inversely with the feed sodium content. The additional

halides added to the feed in Tests 4-6 result on average in about a twenty percent increase in sulfur emissions. Many of these trends, most notably the increase in sulfur emissions with feed sodium content and increased emissions with higher feed halide content, have been previously observed [5-16, 45]; however, the current tests provide a unique data set to evaluate the effect of feed halide and sodium content on emissions because of the systematic changes in glass compositions and the consistency of the test conditions.

As expected, the feed elements emitted at the lowest melter DF in ascending order were rhenium, chlorine, fluorine, sulfur, chromium, potassium, sodium, and boron. Measured rhenium carry-over between 52 and 78 percent of feed is consistent with previous tests conducted with LAW Envelope A simulants at similar feed and glass concentrations [47]. Emissions of chlorine, fluorine, and sulfur were mostly particulate at high sodium and lower halide feed contents. The proportion of these constituents emitted as acid gases increased with increasing feed content. Almost all of the halides present in gas phase were measured in the acidic impinger and not in the basic impinger solutions, indicating that the halides were present as acid gases ($\text{HCl} + \text{HF}$) rather than as homonuclear molecular gases ($\text{Cl}_2 + \text{F}_2$). Boron, sulfur, and the halides were the only elements detected in the impinger solutions collected downstream of the heated particle filter in the sampling train, which constitute the “gas” fraction of the melter emissions.

5.2 Gases Monitored by FTIR

Melter emissions were monitored in each test for a variety of gaseous components, most notably CO and nitrogen species, by Fourier Transform Infra-Red Spectroscopy (FTIR). The off-gas system temperature is maintained well above 100°C beyond the sampling port downstream of the HEPA filter to prevent analyte loss due to condensation prior to monitoring. A summary of average concentrations monitored during each test is provided in Table 5.2. Concentrations of various monitored species are plotted in Figures 5.7.a - 5.11.c. The analytes listed in Table 5.2 are those that were thought likely to be observed during the tests based on previous work; no other species were detected in the off-gas stream by FTIR. The most abundant nitrogen species monitored was NO, which is consistent with previous tests [5-16, 46, 47] in which nitrates and nitrites were present in the feed. The NO₂ concentration was about 10 to 20 times less than NO, in keeping with previous DM100 tests with LAW simulants. Exceptions were Tests 3C and 4A due to the very low concentrations of nitrogen oxides in the feed. As expected, nitrogen oxide concentrations were proportional to the nitrogen oxide content of the feed. Consequently, measured concentrations of by-products of incomplete organic combustion, such as ammonia and carbon monoxide, were proportional to nitrogen oxide concentrations since the feed organic content was adjusted to the feed nitrogen oxide content with additions of sugar (see Section 2.3). The measured water contents were typically between five and six percent and were about half the amount measured by the Method 5-type sampling discussed earlier as result of air inleakage between the two sampling points. This is the same amount of dilution observed in previous studies subsequent to the modification of the exhaust system in July of 2002 [8, 10, 12, 14, 16, 47, 50, 52]. As reported previously [16], an additional 50 scfm of inleakage was measured prior to the modification resulting in exhaust dilutions of about 3 instead of about 2 in early tests [7, 9, 11, 13, 15]. A detailed discussion of melter exhaust dilution by film cooler air and off-gas system inleakage for the purposes of evaluating hydrogen concentrations has been

given previously [53]. Little or no HF or HCl were observed by FTIR in tests conducted without the additional halides added to the feed, whereas HF was detected in the off-gas system exhaust throughout tests with higher halide concentrations, as shown in Figures 5.11.a – 5.11.c. These measurements are in keeping with the gaseous emission rates measured by the Method 5-type sampling and the dilution in between the two sampling points. Conversely, HCl was detected in significant quantities in tests processing high halide feed using the Method 5-type sampling method, but none was detected by the FTIR. The exhaust stream passes through three particulate filters in between the two sampling locations; HCl may react with or adhere to filtered particles thus removing it from the exhaust stream prior to measurement by the FTIR. Similar to previous DM100 LAW tests [7-13, 15, 47], little SO₂ was detected throughout testing. Gaseous sulfur emissions detected using 40-CFR-60 Methods are probably sulfuric acid or SO₂ which was oxidized prior to reaching the down-stream FTIR sampling port. The variations in emissions over the course of each test segment, which may be as high as an order of magnitude are due in part to changes in the melt pool cold cap.

A nitrogen mass balance is summarized in Table 5.3 for each test segment. In all tests but two, about half of the feed nitrogen oxides were reduced to diatomic nitrogen, in keeping with expectations for feed with a sugar ratio of 0.5. No obvious difference in the nitrogen mass balance was observed as a function of simulant composition during these tests. The two test segments with higher relative emissions were Tests 3C and 4A. The feed for both these tests contained a simulant based on an AZ-102 waste composition with all the NaNO₂ removed to accommodate the halide additions (see Table 2.10). As a result, the feed concentrations of nitrogen oxide are so small that contaminant amounts of nitrates in other simulant components and feed additives can significantly affect the mass balance.

5.3 Mass Balance of Volatile Constituents

Table 5.4 provides the elemental mass balance around the melter for sulfur and rhenium for all tests as well as chlorine and fluorine for tests with high feed halide concentrations. The total recovery of these volatile feed constituents was good for all tests except Test 4A. This test was short in duration and followed a long idling period which depleted volatile constituents from the glass and therefore the recoveries for this test were low. Except for one other chlorine value, mass balance closures were between 80 and 120% and almost all of the closures for sulfur and chlorine were within 90 and 110%. Fluorine closures were mostly between 80 and 90%, probably due to a slight low bias in the glass analysis technique. As described in Section 4.1, chlorine, fluorine, and rhenium retention in the glass was typically 50-60%, 65-75%, and 20-40%, respectively, with no obvious influence by the other feed constituents. Sulfur retention in the glass typically ranged from 75-95% depending on feed sodium, sulfur, and halide concentrations. Melter emissions of rhenium were exclusively particulate, whereas sulfur and halide emissions were both particulate and gaseous. The ratio of particulate to gaseous sulfur increased with increasing feed sodium content. Greater proportions of chlorine emissions were particulate, in contrast to fluorine, which had a higher proportion emitted as a gas. These proportions vary greatly between the tests with no obvious relationship to the other feed components.

SECTION 6.0 SUMMARY AND CONCLUSIONS

A series of six tests were conducted on the DM100-WV melter using a range of LAW Sub-Envelope simulants and corresponding melter feeds that produced glasses in the alkali-limited region through the sulfate-limited LAW glass composition region with varying alkali content. In addition, in all of the seven glass compositions that were used, the impact of higher levels of chlorine and fluorine on sulfate phase formation was also investigated. Rhenium as a surrogate for technetium was added to the feed in all tests to provide data on retention in the glass product and the relative proportions of particulate and gaseous fractions in the melter exhaust. The results showed that each glass composition and transitions between glass compositions occurred without the formation of a separate sulfate phase on the melt pool surface. Conversely, separate sulfate phases were observed in most of the tests processing the same glass compositions containing high concentrations of halides. Separated sulfate phases were removed by bubbling the melt pool prior to continuing testing. Sulfate phases were identified by visual observations from multiple dip samples. Visual results were confirmed by chemical and microstructural analysis, which indicated that the material was composed of two principal phases: an alkali and calcium sulfate phase with lesser amounts of chlorine, chromium, and rhenium in addition to a phase of radiating crystals composed of alkali sulfate, chlorine, and chromium. No difficulties were encountered in maintaining nominal operating conditions (glass temperature of 1150°C and a near complete cold cap while processing glass at 2000 kg/m²/day) in any of the tests.

Analysis of the feed samples and product glasses confirmed the composition of the feed and showed the intended transitions between the various compositions. Product glasses were selected to permit direct comparisons with the corresponding crucible melt results at high potassium and high sodium, moderate sodium, and low sodium levels, as well as to assess the effects of the increased halide levels on glass properties. All of the measured properties of the crucible and melter glasses are within acceptable limits for processing and product quality.

During the present tests, total particulate carry-over from the melter ranged from a quarter percent to over two percent and increased with increasing sodium, potassium, and halide feed content. Melter DFs were determined for most of the elements in the feed for each unique glass composition. The most volatile species were rhenium, halogens, and sulfur. Good mass balance closure was obtained for halides, sulfur, and rhenium for most of the test segments. Sulfur retention in the glass typically ranged from 75 - 95% and increased with increased feed sodium content and decreased with increased feed halide content. Chlorine, fluorine, and rhenium retention in the glass was typically 50 - 60%, 65 - 75%, and 20 - 40%, respectively, with no obvious relationship to concentrations of the other feed constituents. Rhenium melter emissions were entirely particulate, whereas chlorine, fluorine, and sulfur melter emissions were both particulate and gaseous. Consistent with previous tests conducted at 0.5 stoichiometric carbon, approximately half of the feed nitrogen oxides were emitted as NO and NO₂ gases.

Byproducts of incomplete combustion, such as carbon monoxide and ammonia increased with the amounts of carbon and nitrogen oxides in the feed.

The results from these tests demonstrate that glass formulations generated by the LAW glass formulation algorithm (including process uncertainties in the worst-case direction) which span a wide range of sodium and sulfate concentrations can be processed without forming separate sulfur phases on the melt surface. However, the results also indicate that separate sulfur phases are likely to form on the melt pool surface if the same feeds contain high halide concentrations. Chemical analysis of this separated material indicates that rhenium, which was used as a surrogate for radioactive technetium, is sequestered into the soluble secondary phase. In the limited number of previous tests with LAW feeds containing high chlorine concentrations, the formation of separated secondary phases was not observed and, therefore, high chlorine concentrations do not appear to be the only determining factor for the formation of secondary phases on the melt pool surface. Consequently, it is recommended that further testing be performed to better understand the relationship between chlorine and fluorine concentrations and the formation of secondary sulfate phases, and to define acceptable limits. It is recommended that this work should include isolating the effect of each of the two halides, defining halide concentration thresholds for secondary phase formation, and processing glasses with high concentrations of halides that in past studies with nominal halide concentrations did not result in secondary sulfate phases. The results of these tests should then be incorporated into a revision of the LAW glass formulation algorithm.

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Table 2.1. Compositions of Glasses for DM100 Melter Testing (wt%).

Glass	LAW E3	LAW E4H**	LAW E5H	LAW E6H	LAW E7H	LAW E9H	LAW E10H
Na ₂ O	18.21	21.27	18.97	15.83	13.53	8.93	4.33
SO ₃	0.35	0.41	0.46	0.53	0.59	0.69	0.80
K ₂ O	4.98	0.00	0.54	0.54	0.54	0.54	0.54
Al ₂ O ₃	6.10	5.97	5.99	6.01	6.02	6.05	6.07
B ₂ O ₃	10.00	9.79	9.81	9.85	9.87	9.92	9.95
Fe ₂ O ₃	5.50	5.38	5.40	5.42	5.43	5.45	5.48
TiO ₂	1.40	1.37	1.37	1.38	1.38	1.39	1.39
ZnO	3.50	3.43	3.43	3.45	3.46	3.47	3.48
ZrO ₂	3.00	2.94	2.94	2.95	2.96	2.97	2.99
CaO	2.02	2.46	3.61	5.46	6.31	6.86	6.96
Li ₂ O	0.00	0.00	0.49	2.38	3.17	4.08	4.26
MgO	1.48	1.45	1.45	1.46	1.49	2.36	2.94
Added Na ₂ O	-	-	-	-	-	-	1.39
Others*	0.50	0.49	0.49	0.50	0.49	0.50	0.50
SiO ₂	42.95	45.04	45.04	44.25	44.75	46.79	48.92
Sum	100.00	100.00	100.00	100.00	100.00	100.00	100.00

* Composition of others is given in Table 2.3

"-" Empty data field

** Melter tests were conducted using LAW E4H glasses targeting 0.00 and 0.54 wt% K₂O. Sodium was held constant at 21.27 wt%; however, increasing K₂O resulted in lower concentrations of other components.

Table 2.2. Test Matrix.

Melter Test	Objective	Feed Composition	Duration (hours)	Cl and F Content (glass basis)
1A	K Effect	LAW E3	50	0.20 wt% Cl
1B		LAW E4H with no K ₂ O	50	0.08 wt% F
2A	Na-S Effects; high Na	LAW E4H	25	0.20 wt% Cl 0.08 wt% F
2B		LAW E5H	50	
2C		LAW 6H	50	
2D		LAW E7H	50	
3A		LAW E7H	25	
3B	Na-S Effects; low Na	LAW E9H	50	0.20 wt% Cl 0.08 wt% F
3C		LAW E10H	50	
4A	Na-S Effects; low Na at high Cl and F	LAW E10H	25	1.1 wt% Cl 1.3 wt% F
4B		LAW E9H	50	
4C		LAW E7H	50	
5A	Na-S Effects; high Na at high Cl and F	LAW E7H	25	1.1 wt% Cl 1.3 wt% F
5B		LAW 6H	50	
5C		LAW E5H	50	
5D		LAW E4H	50	
6A	K Effect at high Cl and F	LAW E4H with no K ₂ O	50	1.1 wt% Cl
6B		LAW E3	50	1.3 wt% F

Table 2.3. Composition of the Grouped Component “Others” for LAWEH Glasses.

Components	Relative Concentrations (wt%)	Concentration in LAWE Glasses (wt%)
Cl	40.01	0.200
Cr ₂ O ₃	16.07	0.080
F	14.97	0.080
NiO	2.00	0.008
PbO	2.00	0.008
P ₂ O ₅	24.95	0.124
Total	100.00	0.500

Table 2.4. LAWE3 Simulant Recipe at Nominal 8 Molar Sodium (Actual 8.46 Molar Sodium) Based on AP-101 Waste Composition [32].

Envelope Constituents	Simulant AP-101 Modified for Maximum K/Na Molar Ratio of 0.18		Glass Oxides	LAW E3 Simulant as Oxides (wt%)	Waste Contribution to Glass	Source in Simulant	Order for Addition	Formula Weight	Assay*	Target Weight (g)
-	mg/L	Molarity	Loading	100%	25.41%	In 439 ml water ^{\$} add following compounds in the order listed below				
Al	9625	0.357	Al ₂ O ₃	5.26	1.34	Al(NO ₃) ₃ ·9H ₂ O, 60% sol.	1	375.14	0.61	220.51
B	12	0.001	B ₂ O ₃	0.01	0.00	H ₃ BO ₃	2	61.83	0.99	0.07
Cr	749	0.014	Cr ₂ O ₃	0.32	0.08	Na ₂ CrO ₄ ·4H ₂ O	8	234.04	0.99	3.42
K	56301	1.440	K ₂ O	19.61	4.98	KOH	7	56.10	0.91	88.97
Na	183920	8.000	Na ₂ O	71.67	18.21	NaOH, 50% sol. d=1.53	6	40.00	0.50	226.00
Ni	82	0.001	NiO	0.03	0.01	NiO	3	74.69	1.00	0.10
Pb	95	0.0005	PbO	0.03	0.01	PbO	4	223.20	1.00	0.10
Si	157	0.006	SiO ₂	0.10	0.02	SiO ₂	5	60.09	0.99	0.34
Cl	2730	0.077	Cl	0.79	0.20	NaCl	10	58.45	0.99	4.55
F	1083	0.057	F	0.31	0.08	NaF	11	42.00	0.99	2.42
PO ₄	2251	0.024	P ₂ O ₅	0.49	0.12	Na ₃ PO ₄ ·12H ₂ O	9	380.12	0.99	9.10
SO ₄	5764	0.060	SO ₃	1.39	0.35	Na ₂ SO ₄	12	142.06	0.99	8.61
NO ₂	58110	1.263	-	-	-	NaNO ₂	16	69.00	1.00	87.60
NO ₃	183067	2.953	-	-	-	NaNO ₃	17	84.99	0.99	161.61
CO ₃	44775	0.746	-	-	-	Na ₂ CO ₃	18	105.99	1.00	79.08
Org.Carbon	2718	0.227	-	-	-	-	-	-	-	-
Acetate	3025	0.051	-	-	-	Sodium Acetate (C2)	13	136.08	0.99	7.04
Formate	2213	0.049	-	-	-	Sodium Formate (C1)	14	68.01	0.99	3.38
Oxalate	3321	0.038	-	-	-	Sodium Oxalate (C2)	15	134.00	0.99	5.11
-	-	-	-	-	-	Target Glass Weight				1361.45
-	-	-	SUM	100.00	25.41	Total simulant Weight				1346.99

"-" Empty data field.

* Assay refers to the purity of the raw material as specified by the vendor.

^{\$} An actual 8 molar sodium simulant was produced at the crucible scale with 494.33 ml water yielding a measured simulant total weight of 1402.32 g.

Table 2.5. LAWE4H Waste Simulant Recipe at Nominal 8 Molar Sodium (Actual 7.97 Molar Sodium) without Potassium Based on AN-105 Waste Composition [32].

Envelope Constituents	Simulant AN-105 Modified for E4H		Glass Oxides	LAW E4H Simulant as Oxides (wt%)	Waste Contribution to Glass	Source in Simulant	Order for Addition	Formula Weight	Assay*	Target Weight (g)
-	mg/L	M	Loading		27.18%	In 274.40 ml water ^{\$} add following compounds in the order listed below				
Al	30554	1.132	Al ₂ O ₃	18.23	4.95	Al(NO ₃) ₃ ·9H ₂ O, 60% sol.	1	375.14	0.61	422.01
						Al(OH) ₃	8	78.00	1.00	35.22
B	79	0.007	B ₂ O ₃	0.08	0.02	H ₃ BO ₃	2	61.83	0.99	0.45
Cr	624	0.012	Cr ₂ O ₃	0.29	0.08	Na ₂ CrO ₄ ·4H ₂ O	9	234.04	0.99	2.85
K	-	-	K ₂ O	0.00	0.00**	KOH	7	56.10	0.91	0.00
Na	183920	8.000	Na ₂ O	78.26	21.27	NaOH, 50% sol. d=1.53	6	40.00	0.50	458.04
Ni	70	0.001	NiO	0.03	0.01	NiO	3	74.69	1.00	0.09
Pb	83	0.0004	PbO	0.03	0.01	PbO	4	223.20	1.00	0.09
Si	157	0.006	SiO ₂	0.11	0.03	SiO ₂	5	60.09	0.99	0.34
Cl	2304	0.065	Cl	0.73	0.20	NaCl	11	58.45	0.99	3.84
F	912	0.048	F	0.29	0.08	NaF	12	42.00	0.99	2.04
PO ₄	1899	0.020	P ₂ O ₅	0.45	0.12	Na ₃ PO ₄ ·12H ₂ O	10	380.12	0.99	7.68
SO ₄	5764	0.060	SO ₃	1.52	0.41	Na ₂ SO ₄	13	142.06	0.99	8.61
NO ₂	85428	1.857	-	-	-	NaNO ₂	17	69.00	0.97	128.79
NO ₃	126988	2.048	-	-	-	NaNO ₃	-	84.99	0.99	0.00
TOC	2093	0.174	-	-	-	-	-	-	-	-
Acetate	2251	0.038	-	-	-	Sodium Acetate (C2)	14	136.08	0.99	5.24
Formate	2135	0.047	-	-	-	Sodium Formate (C1)	15	68.01	0.99	3.26
Glycolate	1936	0.025	-	-	-	Glycolic Acid (C2)	16	76.05	0.71	2.73
-	-	-	-	-	-	Target Glass				1165.59
-	-	-	SUM	100.00	27.18	Total simulant wt.				1355.67

"-" Empty data field.

* Assay refers to the purity of the raw material as specified by the vendor.

** Melter tests were conducted using LAWE4H glasses containing 0.00 and 0.54 wt% K₂O (see Table 2.2)

\$ - An actual 8 molar sodium simulant was produced at the crucible scale with 270.42 ml water and 8.25 g KOH yielding a measured simulant total weight of 1359.94.

Table 2.6. LAWE5H Simulant Recipe at Nominal 7 Molar Sodium (Actual 7.13 Molar Sodium) Based on AN-107 Waste Composition [32].

Envelope Constituents	Simulant AN-107 Modified for E5H		Glass Oxides	LAW E5H Simulant as Oxides (wt%)	Waste Contribution To Glass	Source in Simulant	Order for Addition	Formula Weight	Assay*	Target Weight (g)
-	mg/L	M	Loading		20.64%	In 645 ml water ^{\$} add following compounds in the order listed below				
Al	140	0.005	Al ₂ O ₃	0.11	0.02	Al(NO ₃) ₃ ·9H ₂ O - 60% sol.	1	375.14	0.61	3.21
Ca	309	0.008	CaO	0.18	0.04	Ca(NO ₃) ₂ ·4H ₂ O	2	236.16	0.99	1.84
Cr	613	0.012	Cr ₂ O ₃	0.38	0.08	Na ₂ CrO ₄ ·4H ₂ O	7	234.04	0.99	2.80
Fe	936	0.017	Fe ₂ O ₃	0.57	0.12	Fe(NO ₃) ₃ ·9H ₂ O	4	404.01	1.00	6.78
K	5122	0.131	K ₂ O	2.62	0.54	KOH	6	56.10	0.91	8.09
Na	160930	7.000	Na ₂ O	91.92	18.97	NaOH - 50% sol. d=1.53	5	40.00	0.50	297.25
Ni	68	0.001	NiO	0.04	0.01	NiO	8	74.69	1.00	0.09
Pb	82	0.0004	PbO	0.04	0.01	PbO	9	223.20	1.00	0.09
Cl	2246	0.063	Cl	0.95	0.20	NaCl	11	58.45	0.99	3.74
F	887	0.047	F	0.38	0.08	NaF	12	42.00	0.99	1.98
PO ₄	1861	0.020	P ₂ O ₅	0.59	0.12	Na ₃ PO ₄ ·12H ₂ O	10	380.12	0.99	7.53
SO ₄	6310	0.066	SO ₃	2.23	0.46	Na ₂ SO ₄	13	142.06	0.99	9.43
NO ₂	36013	0.783	-	-	-	NaNO ₂	23	69.00	1.00	54.29
NO ₃	116010	1.871	-	-	-	NaNO ₃	24	84.99	0.99	153.65
Org.Carbon	21597	1.800	-	-	-	-	-	-	-	-
EDTA	5123	0.018	-	-	-	Na ₂ EDTA·2H ₂ O (C10)	14	372.24	0.99	6.64
HEDTA	5123	0.019	-	-	-	Na ₃ HEDTA (C10) - 41% sol.	15	344.20	0.42	15.44
Acetate	5123	0.087	-	-	-	Sodium Acetate (C2)	16	136.08	0.99	11.92
Formate	5123	0.114	-	-	-	Sodium Formate (C1)	17	68.01	0.99	7.82
Oxalate	2846	0.032	-	-	-	Sodium Oxalate (C2)	18	134.00	0.99	4.38
Gluconate	4269	0.022	-	-	-	Sodium Gluconate (C6)	3	218.14	0.99	4.82
Glycolic	11385	0.150	-	-	-	Glycolic Acid (C2)	19	76.05	0.71	16.06
NTA	4554	0.024	-	-	-	Nitrilotriacetic Acid (C6)	20	191.14	0.98	4.65
Citric	12524	0.065	-	-	-	Citric Acid (C6)	21	192.12	0.99	12.65
Iminodiacetic	4013	0.030	-	-	-	Iminodiacetic Acid (C4)	22	133.10	0.98	4.10
-	-	-	-	-	-	Target Glass				1143.54
-	-	-	SUM	100.00	20.64	Total simulant weight				1284.23

"-" Empty data field.

* Assay refers to the purity of the raw material as specified by the vendor.

\$ - An actual 7 molar sodium simulant was produced at the crucible scale with 664.01 ml water yielding a measured simulant total weight of 1303.24 g.

Table 2.7. LAWE6H Simulant Recipe at Nominal 7 Molar Sodium (Actual 6.86 Molar Sodium) Based on AN-104 Waste Composition [32].

Envelope Constituents	Simulant AN-104 Modified for E6H		Glass Oxides	LAW E6H Simulant as Oxides (wt%)	Waste Contribution To Glass	Source in Simulant	Order for Addition	Formula Weight	Assay*	Target Weight (g)
-	mg/L	Molarity	Loading	-	20.88%	In 400 ml water ^{\$} add following compounds in the order listed below				
Al	25069	0.929	Al ₂ O ₃	16.55	3.46	Al(NO ₃) ₃ ·9H ₂ O, 60% sol.	1	375.14	0.61	412.76
-	-	-	-	-	-	Al(OH) ₃	4	78.00	1.00	20.47
Cr	734	0.014	Cr ₂ O ₃	0.37	0.08	Na ₂ CrO ₄ ·4H ₂ O	5	234.04	0.99	3.35
K	6140	0.157	K ₂ O	2.58	0.54	KOH	3	56.10	0.91	9.70
Na	160930	7.000	Na ₂ O	75.81	15.83	NaOH, 50% sol. d=1.53	2	40.00	0.50	294.59
Ni	84	0.001	NiO	0.04	0.01	NiO	6	74.69	1.00	0.11
Pb	99	0.001	PbO	0.04	0.01	PbO	7	223.20	1.00	0.11
Si	228	0.008	SiO ₂	0.17	0.04	SiO ₂	8	60.09	0.99	0.49
Cl	2688	0.076	Cl	0.94	0.20	NaCl	10	58.45	0.99	4.48
F	1064	0.056	F	0.37	0.08	NaF	11	42.00	0.99	2.38
PO ₄	2238	0.024	P ₂ O ₅	0.58	0.12	Na ₃ PO ₄ ·12H ₂ O	9	380.12	0.99	9.05
SO ₄	8708	0.091	SO ₃	2.54	0.53	Na ₂ SO ₄	12	142.06	0.99	13.01
NO ₂	78634	1.709	NO ₂	-	-	NaNO ₂	15	69.00	1.00	118.54
NO ₃	124203	2.003	NO ₃	-	-	NaNO ₃		84.99	0.99	0.00
CO ₃	31659	0.528	CO ₃	-	-	Na ₂ CO ₃	16	105.99	1.00	55.92
Org. Carbon	2044	0.170	-	-	-	-	-	-	-	-
Acetate	2284	0.039	-	-	-	Sodium Acetate (C2)	13	136.08	0.99	5.31
Formate	4176	0.093	-	-	-	Sodium Formate (C1)	14	68.01	0.99	6.37
-	-	-	-	-	-	Target Glass Weight				1370.37
-	-	-	SUM	100.00	20.88	Estimated ^{\$} Total Simulant Weight				1356.64

"-" Empty data field.

* Assay refers to the purity of the raw material as specified by the vendor.

^{\$} An actual 7 molar sodium simulant was produced at the crucible scale with 380.21 ml water yielding a measured simulant total weight of 1336.85 g.

Table 2.8. LAWE7H Simulant Recipe at Nominal 5 Molar Sodium (Actual 5.02 Molar Sodium) Based on AN-102 Waste Composition [32].

Envelope Constituents	Simulant AN-102 Modified for E7H		Glass Oxides	LAW E7H Simulant as Oxides (wt%)	Waste Contribution to Glass	Source in Simulant	Order for Addition	Formula Weight	Assay*	Target Weight (g)
-	mg/L	Molarity	Loading	-	16.22%	In 686 ml water ^{\$} add following compounds in the order listed below				
Al	6201	0.230	Al ₂ O ₃	6.31	1.02	Al(NO ₃) ₃ ·9H ₂ O, 60% sol.	1	375.14	0.61	142.07
B	18	0.002	B ₂ O ₃	0.03	0.01	H ₃ BO ₃	3	61.83	0.99	0.11
Ca	248	0.006	CaO	0.19	0.03	Ca(NO ₃) ₂ ·4H ₂ O	2	236.16	0.99	1.47
Cr	608	0.012	Cr ₂ O ₃	0.48	0.08	Na ₂ CrO ₄ ·4H ₂ O	6	234.04	0.99	2.78
K	5137	0.131	K ₂ O	3.33	0.54	KOH	5	56.10	0.91	8.12
Na	114950	5.000	Na ₂ O	83.41	13.53	NaOH, 50% sol. D=1.53	4	40.00	0.50	102.73
Ni	70	0.001	NiO	0.05	0.01	NiO	7	74.69	1.00	0.09
Pb	83	0.0004	PbO	0.05	0.01	PbO	8	223.20	1.00	0.09
Si	46	0.002	SiO ₂	0.05	0.01	SiO ₂	9	60.09	0.99	0.10
Cl	2248	0.063	Cl	1.21	0.20	NaCl	11	58.45	0.99	3.74
F	893	0.047	F	0.48	0.08	NaF	12	42.00	0.99	1.99
PO ₄	1871	0.020	P ₂ O ₅	0.75	0.12	Na ₃ PO ₄ ·12H ₂ O	10	380.12	0.99	7.56
SO ₄	8165	0.085	SO ₃	3.66	0.59	Na ₂ SO ₄	13	142.06	0.99	12.20
NO ₂	43205	0.939	NO ₂	-	-	NaNO ₂	18	69.00	1.00	65.13
NO ₃	111873	1.804	NO ₃	-	-	NaNO ₃	19	84.99	0.99	94.65
CO ₃	27723	0.462	CO ₃	-	-	Na ₂ CO ₃	20	105.99	1.00	48.96
Org. Carbon	14731	1.228	-	-	-	-	-	-	-	-
Formate	16320	0.363	-	-	-	Sodium Formate (C1)	14	68.01	0.99	24.91
Oxalate	938	0.011	-	-	-	Sodium Oxalate (C2)	15	134.00	0.99	1.44
Glycolate	21420	0.282	-	-	-	Glycolic Acid (C2)	16	76.05	0.71	30.22
Citric Acid	8976	0.047	-	-	-	Citric Acid (C6)	17	192.12	0.99	9.07
-	-	-	-	-	-	Target Glass Weight				1145.23
-	-	-	SUM	100.00	16.22	Total Simulant Weight				1243.44

"-" Empty data field.

* Assay refers to the purity of the raw material as specified by the vendor.

\$ An actual 5 molar sodium simulant was produced at the crucible scale with 689.14 ml water yielding a measured simulant total weight of 1246.58 g.

Table 2.9. LAWE9H Simulant Recipe at Nominal 4 Molar Sodium Based on AZ-101 Waste Composition [32].

Envelope Constituents	Simulant AZ-101 Modified for E9H		Glass Oxides	LAW E9H Simulant as Oxides (wt%)	Waste Contribution to Glass	Source in Simulant	Order for Addition	Formula Weight	Assay*	Target Weight (g)
-	mg/L	M	Loading		11.34 %	In 806 ml water add following compounds in the order listed below				
Al	4761	0.176	Al ₂ O ₃	5.71	0.65	Al(NO ₃) ₃ ·9H ₂ O, 60% sol.	1	375.14	0.61	109.07
Ca	360	0.009	CaO	0.32	0.04	Ca(NO ₃) ₂ ·4H ₂ O	2	236.16	0.99	2.14
Cr	741	0.014	Cr ₂ O ₃	0.69	0.08	Na ₂ CrO ₄ ·4H ₂ O	5	234.04	0.99	3.39
K	6227	0.159	K ₂ O	4.77	0.54	KOH	4	56.10	0.91	9.84
Na	91960	4.000	Na ₂ O	78.74	8.93	NaOH, 50% sol. d=1.53	3	40.00	0.50	185.67
Ni	85	0.002	NiO	0.07	0.01	NiO	6	74.69	1.00	0.11
Pb	101	0.001	PbO	0.07	0.01	PbO	7	223.20	1.00	0.11
Si	53	0.002	SiO ₂	0.07	0.01	SiO ₂	8	60.09	0.99	0.12
Cl	2723	0.077	Cl	1.73	0.20	NaCl	10	58.45	0.99	4.53
F	1078	0.057	F	0.69	0.08	NaF	11	42.00	0.99	2.41
PO ₄	2245	0.077	P ₂ O ₅	1.07	0.12	Na ₃ PO ₄ ·12H ₂ O	9	380.12	0.99	9.08
SO ₄	11485	0.120	SO ₃	6.08	0.69	Na ₂ SO ₄	12	142.06	0.99	17.16
NO ₂	48214	1.048	NO ₂	-	-	NaNO ₂	15	69.00	1.00	72.68
NO ₃	41345	0.667	NO ₃	-	-	NaNO ₃	16	84.99	0.99	10.26
CO ₃	38740	0.646	CO ₃	-	-	[#] Na ₂ CO ₃	17	105.99	1.00	0
Org. Carbon	401	0.033	-	-	-	-	-	-	-	-
formate	393	0.009	-	-	-	Sodium Formate (C1)	13	68.01	0.99	0.60
Oxalate	1085	0.012	-	-	-	Sodium Oxalate (C2)	14	134.00	0.99	1.67
-	-	-	-	-	-	Target Glass Weight				1388.13
-	-	-	SUM	100.00	11.34	Total Simulant Weight				1200.23

"-" Empty data field.

* Assay refers to the purity of the raw material as specified by the vendor.

[#] Na₂CO₃ was omitted to accommodate NaF and NaCl additions in Tests 4-6 and NaOH in Tests 1-3.

Table 2.10. LAWE10H Simulant Recipe at 2 Molar Sodium Based on AZ-102 Waste Composition [32].

Envelope Constituents	Simulant AZ-102 Modified for E10H		Glass Oxides	LAW E10H Simulant as Oxides (wt%)	Waste Contribution to Glass	Source in Simulant	Order for Addition	Formula Weight	Assay	Target Weight (g)
-	mg/L	Molarity	Loading	-	6.20%	In 970 ml water ^s add following compounds in the order listed.				
Al	123	0.005	Al ₂ O ₃	0.26	0.02	Al(NO ₃) ₃ ·9H ₂ O, 60% sol.	2	375.14	0.61	2.82
Cr	760	0.015	Cr ₂ O ₃	1.25	0.08	Na ₂ CrO ₄ ·4H ₂ O	5	234.04	0.99	3.47
K	6412	0.164	K ₂ O	8.70	0.54	KOH	4	56.098	0.91	10.13
Na	45980	2.000	Na ₂ O	69.84	4.33	NaOH, 50% sol. d=1.53	3	40.00	0.50	108.59
Ni	88	0.002	NiO	0.13	0.01	NiO	6	74.69	1.00	0.11
Pb	103	0.001	PbO	0.13	0.01	PbO	7	223.20	1.00	0.11
Si	171	0.006	SiO ₂	0.41	0.03	SiO ₂	8	60.09	0.99	0.37
Cl	2809	0.079	Cl	3.17	0.20	NaCl	10	58.45	0.99	4.68
F	1111	0.058	F	1.25	0.08	NaF	11	42.00	0.99	2.48
PO ₄	2323	0.024	P ₂ O ₅	1.96	0.12	Na ₃ PO ₄ ·12H ₂ O	9	380.12	0.99	9.39
SO ₄	13744	0.143	SO ₃	12.91	0.80	Na ₂ SO ₄	12	142.06	0.99	20.53
NO ₂	23680	0.515	NO ₂	-	-	[#] NaNO ₂	14	69.00	1.00	0
NO ₃	7837	0.126	NO ₃	-	-	NaNO ₃	15	84.99	0.99	9.67
CO ₃	23080	0.385	CO ₃	-	-	[#] Na ₂ CO ₃	1	105.99	1.00	0
Org. Carbon	608	0.051	-	-	-	-	-	-	-	-
Oxalate	2242	0.025	-	-	-	Oxalic Acid (C2)	13	126.00	1.00	3.21
-	-	-	-	-	-	Target Glass				1431.41
-	-	-	SUM	100.00	6.20	Total simulant wt.				1094.47

"-" Empty data field.

* Assay refers to the purity of the raw material as specified by the vendor.

- Na₂CO₃ and NaNO₂ were omitted to accommodate NaF and NaCl additions in Tests 4-6 and NaOH in Tests 1-3.

**Table 2.11. Oxide Composition of LAWE3 Simulant
and Corresponding Glass Composition.**

GLASS	AP-101 in LAWE3 Glass at 18.21 wt% Na ₂ O	Glass Former Additives (wt%)	LAWE3 (wt%)
Loading	25.41%	74.59%	25.41%
Al ₂ O ₃	1.34	4.76	6.10
B ₂ O ₃	0.00	10.00	10.00
CaO	0.00	2.02	2.02
Cr ₂ O ₃	0.08	0.00	0.08
Fe ₂ O ₃	0.00	5.50	5.50
K ₂ O	4.98	0.00	4.98
Li ₂ O	0.00	0.00	0.00
MgO	0.00	1.48	1.48
Na ₂ O	18.21	0.00	18.21
NiO	0.01	0.00	0.01
PbO	0.01	0.00	0.01
SiO ₂	0.02	42.93	42.95
TiO ₂	0.00	1.40	1.40
ZnO	0.00	3.50	3.50
ZrO ₂	0.00	3.00	3.00
Cl	0.20	0.00	0.20
F	0.08	0.00	0.08
P ₂ O ₅	0.12	0.00	0.12
SO ₃	0.35	0.00	0.35
Sum	25.41	74.59	100.00

**Table 2.12. Oxide Composition of LAWE4H Simulant
and Corresponding Glass Composition.**

GLASS	AN-105 in LAWE4H Glass at 21.27 wt% Na ₂ O	Glass Former Additives (wt%)	LAWE4H Without K (wt%)	LAWE4H (wt%)
Loading	27.18%	72.82%	27.18%	27.72%
Al ₂ O ₃	4.95	1.02	5.97	5.93
B ₂ O ₃	0.02	9.77	9.79	9.72
CaO	0.00	2.46	2.46	2.44
Cr ₂ O ₃	0.08	0.00	0.08	0.08
Fe ₂ O ₃	0.00	5.38	5.38	5.34
K ₂ O*	0.00 (or 0.54)	0.00	0.00	0.54
Li ₂ O	0.00	0.00	0.00	0.00
MgO	0.00	1.45	1.45	1.44
Na ₂ O	21.27	0.00	21.27	21.27
NiO	0.01	0.00	0.01	0.01
PbO	0.01	0.00	0.01	0.01
SiO ₂	0.03	45.01	45.04	44.73
TiO ₂	0.00	1.37	1.37	1.36
ZnO	0.00	3.43	3.43	3.41
ZrO ₂	0.00	2.94	2.94	2.92
Cl	0.20	0.00	0.20	0.20
F	0.08	0.00	0.08	0.08
P ₂ O ₅	0.12	0.00	0.12	0.12
SO ₃	0.41	0.00	0.41	0.41
Sum	27.18	72.82	100.00	100.00

* Melter tests were conducted using LAWE4H glasses targeting 0.00 and 0.54 wt% K₂O. Sodium was held constant at 21.27 wt%; however, increasing K₂O resulted in lower concentrations of other components.

**Table 2.13. Oxide Composition of LAWE5H Simulant
and Corresponding Glass Composition.**

GLASS	AN-107 in LAWE5H Glass at 18.97 wt% Na ₂ O	Glass Former Additives (wt%)	LAWE5H (wt%)
Loading	20.64%	79.36%	20.64%
Al ₂ O ₃	0.02	5.97	5.99
B ₂ O ₃	0.00	9.81	9.81
CaO	0.04	3.57	3.61
Cr ₂ O ₃	0.08	0.00	0.08
Fe ₂ O ₃	0.12	5.29	5.40
K ₂ O	0.54	0.00	0.54
Li ₂ O	0.00	0.49	0.49
MgO	0.00	1.45	1.45
Na ₂ O	18.97	0.00	18.97
NiO	0.01	0.00	0.01
PbO	0.01	0.00	0.01
SiO ₂	0.00	45.04	45.04
TiO ₂	0.00	1.37	1.37
ZnO	0.00	3.43	3.43
ZrO ₂	0.00	2.94	2.94
Cl	0.20	0.00	0.20
F	0.08	0.00	0.08
P ₂ O ₅	0.12	0.00	0.12
SO ₃	0.46	0.00	0.46
Sum	20.64	79.36	100.00

**Table 2.14. Oxide Composition of LAWE6H Simulant
and Corresponding Glass Composition.**

GLASS	AN-104 in LAWE6H Glass at 15.83 wt% Na ₂ O	Glass Former Additives (wt%)	LAWE6H (wt%)
Loading	20.88%	79.12%	20.88%
Al ₂ O ₃	3.46	2.55	6.01
B ₂ O ₃	0.00	9.85	9.85
CaO	0.00	5.46	5.46
Cr ₂ O ₃	0.08	0.00	0.08
Fe ₂ O ₃	0.00	5.42	5.42
K ₂ O	0.54	0.00	0.54
Li ₂ O	0.00	2.38	2.38
MgO	0.00	1.46	1.46
Na ₂ O	15.83	0.00	15.83
NiO	0.01	0.00	0.01
PbO	0.01	0.00	0.01
SiO ₂	0.04	44.21	44.25
TiO ₂	0.00	1.38	1.38
ZnO	0.00	3.45	3.45
ZrO ₂	0.00	2.95	2.95
Cl	0.20	0.00	0.20
F	0.08	0.00	0.08
P ₂ O ₅	0.12	0.00	0.12
SO ₃	0.53	0.00	0.53
Sum	20.88	79.12	100.00

**Table 2.15. Oxide Composition of LAWE7H Simulant
and Corresponding Glass Composition.**

GLASS	AN-102 in LAWE7H Glass at 13.53 wt% Na ₂ O	Glass Former Additives (wt%)	LAWE7H (wt%)
Loading	16.22%	83.78%	16.22%
Al ₂ O ₃	1.02	5.00	6.02
B ₂ O ₃	0.01	9.86	9.87
CaO	0.03	6.28	6.31
Cr ₂ O ₃	0.08	0.00	0.08
Fe ₂ O ₃	0.00	5.43	5.43
K ₂ O	0.54	0.00	0.54
Li ₂ O	0.00	3.17	3.17
MgO	0.00	1.49	1.49
Na ₂ O	13.53	0.00	13.53
NiO	0.01	0.00	0.01
PbO	0.01	0.00	0.01
SiO ₂	0.01	44.75	44.75
TiO ₂	0.00	1.38	1.38
ZnO	0.00	3.46	3.46
ZrO ₂	0.00	2.96	2.96
Cl	0.20	0.00	0.20
F	0.08	0.00	0.08
P ₂ O ₅	0.12	0.00	0.12
SO ₃	0.59	0.00	0.59
Sum	16.22	83.78	100.00

**Table 2.16. Oxide Composition of LAWE9H Simulant
and Corresponding Glass Composition.**

GLASS Oxides	AZ-101 in LAWE9H Glass at 8.93 wt% Na ₂ O	Glass Former Additives (wt%)	LAWE9H (wt%)
Loading	11.34%	88.66%	11.34%
Al ₂ O ₃	0.65	5.41	6.05
B ₂ O ₃	0.00	9.92	9.92
CaO	0.04	6.82	6.86
Cr ₂ O ₃	0.08	0.00	0.08
Fe ₂ O ₃	0.00	5.45	5.45
K ₂ O	0.54	0.00	0.54
Li ₂ O	0.00	4.08	4.08
MgO	0.00	2.36	2.36
Na ₂ O	8.93	0.00	8.93
NiO	0.01	0.00	0.01
PbO	0.01	0.00	0.01
SiO ₂	0.01	46.79	46.79
TiO ₂	0.00	1.39	1.39
ZnO	0.00	3.47	3.47
ZrO ₂	0.00	2.97	2.97
Cl	0.20	0.00	0.20
F	0.08	0.00	0.08
P ₂ O ₅	0.12	0.00	0.12
SO ₃	0.69	0.00	0.69
Sum	11.34	88.66	100.00

**Table 2.17. Oxide Composition of LAWE10H Simulant
and Corresponding Glass Compositions.**

GLASS	AZ-102 in LAWE10H Glass at 4.33 wt% Na ₂ O	Glass Former Additives (wt%)	LAWE10H (wt%)
Loading	6.20%	93.80%	6.20%
Al ₂ O ₃	0.02	6.05	6.07
B ₂ O ₃	0.00	9.95	9.95
CaO	0.00	6.96	6.96
Cr ₂ O ₃	0.08	0.00	0.08
Fe ₂ O ₃	0.00	5.48	5.48
K ₂ O	0.54	0.00	0.54
Li ₂ O	0.00	4.26	4.26
MgO	0.00	2.94	2.94
Na ₂ O	4.33	1.39	5.72
NiO	0.01	0.00	0.01
PbO	0.01	0.00	0.01
SiO ₂	0.02	48.90	48.92
TiO ₂	0.00	1.39	1.39
ZnO	0.00	3.48	3.48
ZrO ₂	0.00	2.99	2.99
Cl	0.20	0.00	0.20
F	0.08	0.00	0.08
P ₂ O ₅	0.12	0.00	0.12
SO ₃	0.80	0.00	0.80
Sum	6.20	93.80	100.00

Table 2.18. Glass Former Additives for 1 Liter of LAWE Waste Simulant and Corresponding Feed Properties in Crucible Scale Tests.

Additive Source	Feed LAWE3	Feed LAWE4H*	Feed LAWE5H	Feed LAWE6H	Feed LAWE7H	Feed LAWE9H	Feed LAWE10H
Additives in Glass (wt%)	74.59%	72.82%	79.36%	79.12%	83.78%	88.66%	93.80%
Kyanite (Al ₂ SiO ₅) 325 Mesh (Kyanite Mining) (g)	111.67	18.15	117.42	56.86	96.64	126.86	147.13
H ₃ BO ₃ (US Borax – Technical Granular) (g)	241.75	202.23	199.26	239.75	200.67	244.59	253.08
Wollastonite NYAD 325 Mesh (NYCO Minerals) (g)	60.51	63.09	89.88	164.63	158.24	208.41	219.20
Fe ₂ O ₃ (97% Alfa) (g)	71.35	60.14	57.43	71.07	59.21	70.04	71.22
Li ₂ CO ₃ (Chemetall Foote Co. Technical grade)	-	-	14.01	81.55	90.77	141.60	152.46
Olivine (Mg ₂ SiO ₄) 325 Mesh (#180 Unimin) (g)	41.36	34.48	33.34	39.26	33.18	65.34	84.78
Na ₂ CO ₃ (Technical grade) (g)	-	-	-	-	-	-	34.18
SiO ₂ (Sil-co-Sil 75 US Silica) (g)	468.23	446.62	387.91	459.37	358.02	438.69	465.92
TiO ₂ (Rutile Airfloated Chemaloy) (g)	20.20	16.92	16.60	20.04	16.75	20.45	21.08
ZnO (KADOX – 920 Zinc Corp. of America) (g)	47.65	39.98	39.22	47.28	39.63	48.17	49.81
Zircon ZrSiO ₄ (Flour) Mesh 325 (AM. Mineral) (g)	61.60	51.69	50.71	60.97	51.13	62.18	64.55
Sucrose as Reductant (added only to actual melter feed) (g)	83.65	78.50	5.44	74.50	23.70	35.71	12.26
Measured Simulant Weight for 1 liter (g)	1402	1360	1303	1337	1247	1178	1094
Sum of Additives (g)	1124	933	1006	1241	1104	1426	1563
Sum of Complete Batch (g)	2527	2293	2309	2578	2351	2604	2659
Final Volume (l)	1.452	1.324	1.383	1.490	1.425	1.572	1.583
Measured Density on crucible batch (g/ml)	1.74	1.69	1.67	1.73	1.65	1.67	1.68
Target Glass Produced (g/l simulant)	1361	1166	1144	1370	1145	1388	1431
Measured Weight % Water in Slurry Feed on crucible batch	35%	40%	41%	35%	40%	39%	40%
Target Weight % Additives in Slurry	45%	48%	44%	48%	47%	54%	59%
Target Glass Yield for crucible batch (g/kg of Feed)	539	508	495	532	487	529	538
Measured Glass Yield on crucible batch (g/kg of Feed)	500	480	495	510	479	514	536
Target Glass Yield (g/l of Feed) [#]	938	859	827	920	804	883	1008
Target Total Solids (g/l of Feed)	1126	1012	993	1127	988	1020	988
Target Additives (g/l of Feed)	774	688	727	833	775	907	983

* Includes 0.56 wt% K₂O, # - target values given in g/l are the product of a target g/kg feed value and the measured density.

"-" Empty data field

Table 2.19. Adjustments to Feed Required for Tests Targeting 1.1 wt% Cl and 1.3 wt% F in the Glass Product and Corresponding Feed Properties.

Test	LAW3	LAW4H	LAW5H	LAW6H	LAW7H	LAW9H	LAW10H
	6B	6A	5C	5B	4C and 5A	4B	4A
Grams of 50% NaOH solution per kg feed omitted from feed received from Optima	41.82	38.49	36.61	38.92	36.54	40.52	40.95
Grams NaCl per kg feed	8.65	7.97	7.58	8.07	7.57	8.40	8.48
Grams NaF per kg feed	16.02	14.74	14.01	14.90	13.99	15.51	15.68
Grams water per kg feed	20.91	19.25	18.30	19.46	18.27	20.26	55.52*
Measured Density (g/ml)	1.66	1.68	1.66	1.70	1.62	1.73	1.60
Measured Weight % Water in Slurry Feed	37%	39%	40%	36%	46%	34%	41%
Measured Glass Yield (g/kg of Feed)	514	483	486	504	467	528	521

* 35.05 g of the 55.52 g of water added was to obtain acceptable feed rheological properties

Table 2.20. Measured Properties of Melter Feed Samples.

Test	Sampling Date	Sample Name	%Water	Density (g/ml)	Glass Yield		pH
					(kg/kg)	(g/l)	
1A	6/13/05	WVZ-F-39A	NA	NA	NA	NA	NA
	6/14/05	WVZ-F-48A	36.28	1.65	0.500	825	11.96
	6/15/05	WVZ-F-65A	36.04	1.62	0.516	836	11.83
	Target*		35.28	1.74	0.533	927	11.94
1B	6/16/05	WVZ-F-80A	40.39	1.66	0.474	787	12.88
	6/17/05	WVZ-F-97A	39.98	1.62	0.478	774	12.80
	Target		40.12	1.69	0.491	830	12.95
2A	6/22/05	WVZ-F-106A	40.72	1.60	0.482	770	12.98
	Target		40.12	1.69	0.491	830	12.95
2B	6/23/05	WVZ-F-140A	41.03	1.68	0.485	814	12.63
	6/24/05	WVZ-F-152A	41.29	1.65	0.486	802	12.59
	Target		40.56	1.67	0.482	805	12.59
2C	6/25/05	AWV-F-16A	36.28	1.70	0.497	845	10.74
	6/26/05	AWV-F-30A	36.53	1.71	0.497	850	10.47
	Target		34.83	1.73	0.499	863	9.87
2D	6/27/05	AWV-F-54A	41.25	1.56	0.469	732	9.32
	6/28/05	AWV-F-68A	46.01	1.60	0.474	758	9.24
	6/29/05	AWV-F-78A	40.44	1.64	0.479	786	9.18
	Target		40.15	1.65	0.478	789	7.61
3A	7/6/05	AWV-F-97A	41.98	1.62	0.479	775	9.37
	Target		40.15	1.65	0.478	789	7.61
3B	7/7/05	AWV-F-118A	40.89	1.66	0.504	837	9.93
	7/8/05	AWV-F-135A	40.36	1.67	0.506	846	9.89
	Target		38.91	1.67	0.526	878	7.84
3C	7/9/05	AWV-F-148A	40.59	1.66	0.533	884	9.88
	7/10/05	BWV-F-14A	41.32	1.66	0.525	872	9.85
	7/11/05	BWV-F-32A	40.10	1.67	0.540	901	9.91
	Target		39.81	1.68	0.538	904	7.50
4A	8/15/05	BWV-F-58A	40.66	1.50	0.484	726	8.77
	Target		41.45	1.60	0.519	830	8.74
4B	8/16/05	BWV-F-72A	NA	NA	NA	NA	NA
	8/17/05	BWV-F-86A	39.88	1.67	0.516	862	8.22
	Target		38.84	1.69	0.524	886	8.54
4C	8/18/05	BWV-F-111A	NA	NA	NA	NA	NA
	8/19/05	BWV-F-128A	42.36	1.59	0.458	728	7.79
	8/20/05	BWV-F-142A	NA	NA	NA	NA	NA
	Target		45.83	1.62	0.476	771	7.69
5A	8/24/05	CWV-F-7A	42.27	1.61	0.466	750	7.88
	Target		45.83	1.62	0.476	771	7.69
5B	8/25/05	CWV-F-35A	30.28	1.68	0.495	831	9.28
	8/26/05	CWV-F-45A	36.69	1.70	NA	NA	9.09
	Target		35.68	1.70	0.497	845	8.19

NA – Not analyzed

* - Values from tests of crucible batch feeds except glass yield (kg/kg) which is calculated from recipe.

Table 2.20. Measured Properties of Melter Feed Samples (continued).

Test	Sampling Date	Sample Name	%Water	Density (g/ml)	Glass Yield		pH
					(kg/kg)	(g/l)	
5C	8/27/05	CWV-F-61A	NA	NA	NA	NA	NA
	8/28/05	CWV-F-75A	40.65	1.65	0.492	811	11.29
	Target		40.43	1.66	0.481	798	11.18
5D	8/29/05	CWV-F-97A	NA	NA	NA	NA	NA
	8/30/05	CWV-F-105A	39.66	1.66	0.465	772	11.63
	8/31/05	CWV-F-125A	30.36	1.60	0.485	778	11.63
	Target		38.83	1.68	0.487	818	11.42
6A	9/12/05	CWV-F-132A	40.04	1.66	0.467	775	11.49
	9/13/05	CWV-F-155A	33.53	1.58	0.469	740	11.61
	Target		38.83	1.68	0.489	822	11.42
6B	9/14/05	DWV-F-39A	38.04	1.74	0.517	899	11.38
	9/15/05	DWV-F-52A	32.52	1.75	0.520	910	10.97
	Target		33.86	1.66	0.531	891	11.01

NA – Not analyzed

* - Values from tests of crucible batch feeds except glass yield (kg/kg) which is calculated from recipe.

Table 2.21. Rheological Properties for Select Melter Feed Samples.

Waste Composition	Test	Sample Name	Yield Stress	Viscosity (Poise)		
			(Pa)	@ 1/s	@ 10/s	@ 100/s
LAW Envelope A	2A	WVZ-F-97A	0.5	2.10	0.49	0.31
	5D	CWV-F-132A	1.3	5.30	0.80	0.38
	Average from previous DM100 Test [8]		0.5	3.14	0.64	0.39
LAW Envelope B	3C	BWV-F-14A	17.9	46.9	5.49	1.34
	Average from previous DM100 Test [13]		13.8	23.2	4.4	1.4

Table 2.22. XRF-Analyzed Compositions of Feed Samples (wt%).

Test	1A						1B					2B				
	Target	WVZ-F-39A	WVZ-F-48A	WVZ-F-65A	Avg.	%Dev.	Target	WVZ-F-80A	WVZ-F-97A	Avg.	%Dev.	Target	WVZ-F-140A	WVZ-F-152A	Avg.	%Dev.
Al ₂ O ₃	6.09	5.87	5.96	6.08	5.97	-2.02	5.96	5.92	5.96	5.94	-0.44	5.98	6.11	5.78	5.95	-0.65
B ₂ O ₃ *	9.99	9.99	9.99	9.99	9.99	NC	9.78	9.78	9.78	9.78	NC	9.80	9.80	9.80	9.80	NC
CaO	2.02	1.90	2.04	1.92	1.95	-3.15	2.46	2.22	2.29	2.25	-8.29	3.61	3.31	3.48	3.39	-5.93
Cl	0.20	0.07	0.12	0.07	0.09	NC	0.20	0.10	0.06	0.08	NC	0.20	0.05	0.05	0.05	NC
Cr ₂ O ₃	0.08	0.13	0.15	0.14	0.14	NC	0.08	0.13	0.14	0.14	NC	0.08	0.14	0.14	0.14	NC
F	0.08	<0.08	<0.08	NA	<0.08	NC	0.08	<0.08	<0.08	0.00	NC	0.08	<0.08	<0.08	<0.08	NC
Fe ₂ O ₃	5.49	5.22	5.46	5.12	5.27	-4.10	5.37	4.72	5.02	4.87	-9.41	5.40	4.91	5.19	5.05	-6.45
K ₂ O	4.98	4.42	5.00	4.68	4.70	-5.62	§	0.18	0.15	0.16	NC	0.54	0.61	0.61	0.61	NC
Li ₂ O*	§	<0.01	<0.01	<0.01	<0.01	NC	§	<0.01	<0.01	<0.01	NC	0.49	0.49	0.49	0.49	NC
MgO	1.48	1.59	1.37	1.50	1.49	0.82	1.45	1.46	1.71	1.59	9.53	1.45	1.41	1.27	1.34	-7.58
Na ₂ O	18.19	18.68	17.53	18.35	18.19	-0.03	21.25	22.70	21.32	22.01	3.60	18.95	18.99	20.08	19.53	3.08
NiO	0.01	<0.01	<0.01	<0.01	<0.01	NC	0.01	<0.01	<0.01	<0.01	NC	0.01	<0.01	<0.01	<0.01	NC
P ₂ O ₅	0.12	0.17	0.19	0.19	0.18	NC	0.12	0.17	0.17	0.17	NC	0.12	0.18	0.18	0.18	NC
PbO	0.01	0.01	0.01	0.08	0.03	NC	0.01	<0.01	<0.01	<0.01	NC	0.01	0.01	0.01	0.01	NC
ReO ₂	0.10	0.01	0.03	0.01	0.02	NC	0.10	0.02	0.02	0.02	NC	0.10	0.01	0.01	0.01	NC
SiO ₂	42.91	42.85	43.85	44.20	43.63	1.68	44.99	45.56	46.19	45.87	1.96	45.00	46.75	44.89	45.82	1.83
SO ₃	0.35	0.24	0.31	0.30	0.28	NC	0.41	0.32	0.29	0.31	NC	0.46	0.33	0.33	0.33	NC
TiO ₂	1.40	1.74	1.63	1.52	1.63	16.48	1.37	1.34	1.40	1.37	-0.10	1.37	1.49	1.57	1.53	11.77
V ₂ O ₅	§	0.01	0.01	0.01	0.01	NC	§	0.01	0.01	0.01	NC	§	0.01	0.01	0.01	NC
ZnO	3.50	3.30	3.18	2.91	3.13	-10.44	3.43	2.74	2.85	2.79	-18.47	3.43	2.85	3.14	3.00	-12.48
ZrO ₂	3.00	3.79	3.17	2.93	3.30	10.04	2.94	2.63	2.65	2.64	-10.15	2.94	2.55	2.97	2.76	-6.00
Sum	100.00	100.00	100.00	100.00	100.00	NC	100.00	100.00	100.00	100.00	NC	100.00	100.00	100.00	100.00	NC

* Target values

§ - Not a target constituent

NC – Not calculated

Table 2.22. XRF-Analyzed Compositions of Feed Samples (wt%) (continued).

Test	2C					2D and 3A							3B				
	Target	AWV-F-16A	AWV-F-30A	Avg.	%Dev.	Target	AWV-F-54A	AWV-F-68A	AWV-F-78A	AWV-F-97A	Avg.	%Dev.	Target	AWV-F-118A	AWV-F-135A	Avg.	%Dev.
Al ₂ O ₃	6.00	5.85	6.00	5.92	-1.36	6.01	5.70	5.89	6.03	6.07	5.92	-1.50	6.05	6.03	5.96	6.00	-0.82
B ₂ O ₃ *	9.84	9.84	9.84	9.84	NC	9.86	9.86	9.86	9.86	9.86	9.86	NC	9.91	9.91	9.91	9.91	NC
CaO	5.45	5.21	5.17	5.19	-4.86	6.30	6.11	6.04	5.93	6.13	6.05	-3.97	6.85	6.38	6.34	6.36	-7.20
Cl	0.20	0.01	0.02	0.01	NC	0.20	0.02	0.02	0.02	0.01	0.02	NC	0.20	0.06	0.07	0.07	NC
Cr ₂ O ₃	0.08	0.15	0.15	0.15	NC	0.08	0.14	0.14	0.13	0.14	0.14	NC	0.08	0.16	0.15	0.15	NC
F	0.08	NA	NA	NC	NC	0.08	NA	NA	NA	NA	NC	NC	0.08	NA	NA	NC	NC
Fe ₂ O ₃	5.41	5.41	5.22	5.32	-1.80	5.42	5.55	5.42	5.34	5.34	5.41	-0.24	5.44	5.17	5.08	5.13	-5.86
K ₂ O	0.54	0.59	0.60	0.60	NC	0.54	0.65	0.61	0.63	0.66	0.64	NC	0.54	0.65	0.62	0.63	NC
Li ₂ O*	2.38	2.38	2.38	2.38	NC	3.17	3.17	3.17	3.17	3.17	3.17	NC	4.08	4.08	4.08	4.08	NC
MgO	1.46	1.36	1.42	1.39	-4.74	1.49	1.51	1.57	1.55	1.19	1.45	-2.38	2.36	2.28	2.29	2.28	-3.09
Na ₂ O	15.81	16.40	16.18	16.29	3.01	13.52	13.60	13.43	12.84	13.38	13.31	-1.51	8.92	9.45	9.50	9.48	6.24
NiO	0.01	<0.01	<0.01	<0.01	NC	0.01	<0.01	<0.01	<0.01	<0.01	0.00	NC	0.01	<0.01	<0.01	<0.01	NC
P ₂ O ₅	0.12	0.17	0.17	0.17	NC	0.12	0.18	0.18	0.18	0.18	0.18	NC	0.12	0.19	0.18	0.19	NC
PbO	0.01	0.01	<0.01	0.01	NC	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	NC	0.01	<0.01	<0.01	<0.01	NC
ReO ₂	0.10	<0.01	0.01	<0.01	NC	0.10	<0.01	<0.01	<0.01	<0.01	<0.01	NC	0.10	0.02	0.02	0.02	NC
SiO ₂	44.21	44.40	45.00	44.70	1.12	44.71	45.17	45.84	46.44	45.50	45.74	2.30	46.75	47.79	48.01	47.90	2.46
SO ₃	0.53	0.29	0.28	0.28	NC	0.59	0.31	0.29	0.28	0.28	0.29	NC	0.69	0.33	0.33	0.33	NC
TiO ₂	1.38	1.48	1.43	1.45	5.45	1.38	1.57	1.53	1.50	1.62	1.55	12.76	1.39	1.56	1.56	1.56	12.28
V ₂ O ₅	§	0.01	0.01	0.01	NC	§	0.01	0.01	0.01	<0.01	0.01	NC	§	0.01	<0.01	0.01	NC
ZnO	3.45	3.28	3.13	3.21	-7.00	3.46	3.29	3.11	3.06	3.35	3.20	-7.37	3.47	3.01	2.99	3.00	-13.41
ZrO ₂	2.95	3.17	3.00	3.08	4.63	2.96	3.16	2.92	3.02	3.12	3.05	3.27	2.97	2.91	2.90	2.90	-2.10
Sum	100.00	100.00	100.00	100.00	NC	100.00	100.00	100.00	100.00	100.00	100.00	NC	100.00	100.00	100.00	100.00	NC

* Target values

§ - Not a target constituent

NA – Not analyzed; NC – Not calculated

Table 2.22. XRF-Analyzed Compositions of Feed Samples (wt%) (continued).

Test	3C						4A			4B			4C and 5A				
	Target	AWV-F-148A	BWV-F-14A	BWV-F-32A	Avg.	%Dev.	Target	BWV-F-58A	%Dev.	Target	BWV-F-86A	%Dev.	Target	BWV-F-128A	CWV-F-7A	Avg.	%Dev.
Al ₂ O ₃	6.06	6.11	6.07	6.02	6.07	0.04	5.93	6.20	4.48	5.92	6.07	2.59	5.89	5.91	6.07	5.99	1.76
B ₂ O ₃ *	9.94	9.94	9.94	9.94	9.94	NC	9.73	9.73	NC	9.70	9.70	NC	9.65	9.65	9.65	9.65	NC
CaO	6.95	6.62	6.63	6.69	6.65	-4.42	6.80	6.68	-1.77	6.71	6.56	-2.13	6.17	6.23	5.77	6.00	-2.80
Cl	0.20	0.09	0.09	0.11	0.10	NC	1.10	0.33	NC	1.10	0.15	NC	1.10	0.11	0.48	0.29	NC
Cr ₂ O ₃	0.08	0.16	0.17	0.16	0.16	NC	0.08	0.15	NC	0.08	0.15	NC	0.08	0.13	0.14	0.14	NC
F	0.08	NA	NA	NA	NC	NC	1.30	0.17	NC	1.30	0.26	NC	1.30	0.27	0.25	0.26	NC
Fe ₂ O ₃	5.47	5.55	5.44	5.51	5.50	0.46	5.36	5.23	-2.32	5.33	5.32	-0.19	5.31	5.28	4.76	5.02	-5.45
K ₂ O	0.54	0.66	0.69	0.66	0.67	NC	0.53	0.62	NC	0.53	0.59	NC	0.53	0.60	0.63	0.61	NC
Li ₂ O*	4.26	4.26	4.26	4.26	4.26	NC	4.17	4.17	NC	3.99	3.99	NC	3.10	3.10	3.10	3.10	NC
MgO	2.94	3.07	2.88	2.88	2.95	0.30	2.87	2.77	-3.47	2.31	2.32	0.50	1.46	1.22	1.39	1.30	-10.54
Na ₂ O	5.71	5.97	5.78	5.75	5.84	2.11	5.59	5.84	4.38	8.73	8.57	-1.82	13.23	13.24	13.50	13.37	1.07
NiO	0.01	<0.01	<0.01	<0.01	<0.01	NC	0.01	<0.01	NC	0.01	<0.01	NC	0.01	<0.01	<0.01	<0.01	NC
P ₂ O ₅	0.12	0.18	0.18	0.18	0.18	NC	0.12	0.22	NC	0.12	0.19	NC	0.12	0.16	0.18	0.17	NC
PbO	0.01	<0.01	<0.01	<0.01	<0.01	NC	0.01	<0.01	NC	0.01	<0.01	NC	0.01	<0.01	<0.01	<0.01	NC
ReO ₂	0.10	0.05	0.05	0.04	0.05	NC	0.10	0.03	NC	0.10	0.02	NC	0.10	0.01	0.02	0.01	NC
SiO ₂	48.88	48.95	49.38	49.19	49.17	0.61	47.83	49.93	4.37	45.75	48.17	5.29	43.76	46.27	46.70	46.48	6.23
SO ₃	0.80	0.45	0.46	0.50	0.47	NC	0.78	0.39	NC	0.67	0.23	NC	0.58	0.25	0.61	0.43	NC
TiO ₂	1.39	1.59	1.59	1.60	1.59	14.60	1.36	1.58	16.55	1.36	1.61	18.17	1.35	1.63	1.46	1.55	14.69
V ₂ O ₅	§	0.01	0.01	0.01	0.01	NC	§	<0.01	NC	§	0.01	NC	§	<0.01	0.01	0.01	NC
ZnO	3.48	3.29	3.27	3.30	3.29	-5.39	3.40	3.07	-9.64	3.39	3.09	-8.86	3.38	2.88	2.82	2.85	-15.84
ZrO ₂	2.99	3.06	3.10	3.19	3.12	4.28	2.92	2.87	-1.69	2.90	3.01	3.66	2.89	3.09	2.45	2.77	-4.33
Sum	100.00	100.00	100.00	100.00	100.00	NC	100.00	100.00	NC	100.00	100.00	NC	100.00	100.00	100.00	100.00	NC

* Target values

§ - Not a target constituent

NA – Not measured; NC – Not calculated

Table 2.22. XRF-Analyzed Compositions of Feed Samples (wt%) (continued).

Test	5B					5C			5D			6A			6B				
	Target	CWV-F-35A	CWV-F-45A	Avg.	%Dev.	Target	CWV-F-75A	%Dev.	Target	CWV-F-125A	%Dev.	Target	CWV-F-132A	%Dev.	Target	DWV-F-39A	DWV-F-52A	Avg.	%Dev.
Al ₂ O ₃	5.88	6.30	5.69	5.99	2.02	5.86	5.88	0.44	5.81	6.19	6.70	5.84	6.38	9.32	5.96	6.29	6.72	6.50	9.03
B ₂ O ₃ *	9.63	9.63	9.63	9.63	NC	9.59	9.59	NC	9.52	9.52	NC	9.57	9.57	NC	9.78	9.78	9.78	9.78	NC
CaO	5.34	5.16	5.24	5.20	-2.61	3.53	3.38	-4.13	2.39	2.37	-0.84	2.41	2.39	-0.66	1.98	1.99	2.05	2.02	2.40
Cl	1.10	0.04	0.50	0.27	NC	1.10	0.51	NC	1.10	0.37	NC	1.10	0.28	NC	1.10	0.19	0.20	0.20	NC
Cr ₂ O ₃	0.08	0.14	0.15	0.14	NC	0.08	0.14	NC	0.08	0.13	NC	0.08	0.14	NC	0.08	0.11	0.11	0.11	NC
F	1.30	0.42	0.42	0.42	NC	1.30	0.39	NC	1.30	0.13	NC	1.30	0.32	NC	1.30	0.30	0.30	0.30	NC
Fe ₂ O ₃	5.30	5.38	5.35	5.37	1.30	5.28	4.97	-5.94	5.23	5.34	2.14	5.26	5.09	-3.31	5.38	5.30	5.38	5.34	-0.69
K ₂ O	0.53	0.50	0.58	0.54	NC	0.53	0.60	NC	0.52	<0.01	NC	§	0.12	NC	4.87	4.36	4.48	4.42	-9.25
Li ₂ O*	2.33	2.33	2.33	2.33	NC	0.48	0.48	NC	§	<0.01	NC	§	<0.01	NC	§	<0.01	<0.01	<0.01	NC
MgO	1.43	1.43	1.44	1.44	0.60	1.42	1.37	-3.29	1.41	1.39	-1.29	1.42	1.27	-10.69	1.45	1.52	1.50	1.51	4.50
Na ₂ O	15.48	15.19	15.24	15.21	-1.70	18.55	18.84	1.56	20.68	20.20	-2.33	20.80	20.69	-0.49	17.81	18.42	17.69	18.06	1.42
NiO	0.01	0.00	<0.01	0.00	NC	0.01	<0.01	NC	0.01	0.00	NC	0.01	<0.01	NC	0.01	<0.01	<0.01	<0.01	NC
P ₂ O ₅	0.12	0.18	0.19	0.18	NC	0.12	0.19	NC	0.12	0.16	NC	0.12	0.16	NC	0.12	0.18	0.19	0.18	NC
PbO	0.01	0.00	<0.01	0.00	NC	0.01	0.01	NC	0.01	<0.01	NC	0.01	0.01	NC	0.01	0.00	0.01	<0.01	NC
ReO ₂	0.10	0.00	0.03	0.01	NC	0.10	0.02	NC	0.10	0.03	NC	0.10	0.01	NC	0.10	0.00	0.01	<0.01	NC
SiO ₂	43.26	45.45	45.04	45.25	4.58	44.04	46.18	4.86	43.80	46.24	5.58	44.03	45.81	4.03	42.00	44.30	44.24	44.27	5.41
SO ₃	0.52	0.16	0.49	0.33	NC	0.45	0.45	NC	0.40	0.28	NC	0.40	0.29	NC	0.35	0.19	0.19	0.19	NC
TiO ₂	1.35	1.47	1.46	1.46	8.56	1.34	1.49	11.03	1.33	1.46	9.64	1.34	1.49	10.97	1.37	1.48	1.50	1.49	9.07
V ₂ O ₅	§	0.01	<0.01	0.00	NC	§	0.01	NC	§	<0.01	NC	§	0.01	NC	§	0.01	0.01	0.01	NC
ZnO	3.37	3.16	3.17	3.16	-6.29	3.35	2.89	-13.91	3.34	3.06	-8.41	3.35	3.02	-10.06	3.42	2.97	2.98	2.97	-13.08
ZrO ₂	2.88	3.05	3.06	3.06	6.02	2.87	2.62	-8.90	2.86	3.10	8.58	2.87	2.95	2.70	2.93	2.61	2.65	2.63	-10.29
Sum	100.00	100.00	100.00	100.00	NC	100.00	100.00	NC	100.00	100.00	NC	100.00	100.00	NC	100.00	100.00	100.00	100.00	NC

* Target values; § - Not a target constituent

NC – Not calculated

Table 2.23. DCP and XRF Analyzed Compositions of Select Melter Feed Samples (wt%).

Test	1A			1B			2B				
	Target	WVZ-F-65A		Target	WVZ-F-80A		Target	WVZ-F-140A		WVZ-F-152A	
		XRF	DCP		XRF	DCP		XRF	DCP	XRF	DCP
Al ₂ O ₃	6.09	6.08	5.97	5.96	5.92	5.70	5.98	6.11	5.61	5.78	5.51
B ₂ O ₃	9.99	9.99*	9.10	9.78	9.78*	9.30	9.80	9.80*	9.41	9.80*	9.55
CaO	2.02	1.92	2.05	2.46	2.22	2.35	3.61	3.31	3.29	3.48	3.33
Cl	0.20	0.07	NA	0.20	0.10	NA	0.20	0.05	NA	0.05	NA
Cr ₂ O ₃	0.08	0.14	0.14	0.08	0.13	0.13	0.08	0.14	0.14	0.14	0.13
F	0.08	NA	NA	0.08	NA	NA	0.08	NA	NA	NA	NA
Fe ₂ O ₃	5.49	5.12	5.47	5.37	4.72	5.23	5.40	4.91	5.08	5.19	5.05
K ₂ O	4.98	4.68	4.95	§	0.18	0.13	0.54	0.61	0.65	0.61	0.64
Li ₂ O	§	0.00*	0.02	§	0.00*	0.02	0.49	0.49*	0.57	0.49*	0.56
MgO	1.48	1.50	1.62	1.45	1.46	1.48	1.45	1.41	1.55	1.27	1.38
Na ₂ O	18.19	18.35	15.68	21.25	22.70	18.73	18.95	18.99	16.56	20.08	16.96
NiO	0.01	<0.01	0.02	0.01	<0.01	0.02	0.01	<0.01	0.02	<0.01	0.02
P ₂ O ₅	0.12	0.19	0.22	0.12	0.17	0.20	0.12	0.18	0.18	0.18	0.25
PbO	0.01	0.08	0.02	0.01	<0.01	0.01	0.01	0.01	0.01	0.01	0.01
ReO ₂	0.10	0.01	0.01	0.10	0.02	0.03	0.10	0.01	0.02	0.01	0.01
SiO ₂	42.91	44.20	40.84	44.99	45.56	43.22	45.00	46.75	43.61	44.89	43.85
SO ₃	0.35	0.30	NA	0.41	0.32	NA	0.46	0.33	NA	0.33	NA
TiO ₂	1.40	1.52	1.62	1.37	1.34	1.48	1.37	1.49	1.61	1.57	1.59
ZnO	3.50	2.91	3.29	3.43	2.74	3.25	3.43	2.85	3.26	3.14	3.31
ZrO ₂	3.00	2.93	3.03	2.94	2.63	2.80	2.94	2.55	2.72	2.97	2.71
Sum	100.00	100.00	94.05	100.00	100.00	94.07	100.00	100.00	94.29	100.00	94.86

* - Target values used for normalizing XRF data.

§ - Not a target constituent

NA – Not analyzed

**Table 2.23. DCP and XRF Analyzed Compositions of Select Melter Feed Samples (wt%)
(continued).**

Test	2C					3B				
	Target	AWV-F-16A		AWV-F-30A		Target	AWV-F-118A		AWV-F-135A	
		XRF	DCP	XRF	DCP		XRF	DCP	XRF	DCP
Al ₂ O ₃	6.00	5.85	5.97	6.00	6.19	6.05	6.03	5.97	5.96	5.87
B ₂ O ₃	9.84	9.84*	9.57	9.84*	9.28	9.91	9.91*	9.59	9.91*	9.97
CaO	5.45	5.21	5.37	5.17	6.81	6.85	6.38	6.66	6.34	6.55
Cl	0.20	0.01	NA	0.02	NA	0.20	0.06	NA	0.07	NA
Cr ₂ O ₃	0.08	0.15	0.14	0.15	0.14	0.08	0.16	0.14	0.15	0.14
F	0.08	NA	NA	NA	NA	0.08	NA	NA	NA	NA
Fe ₂ O ₃	5.41	5.41	4.90	5.22	4.79	5.44	5.17	4.88	5.08	5.11
K ₂ O	0.54	0.59	0.60	0.60	0.61	0.54	0.65	0.66	0.62	0.65
Li ₂ O	2.38	2.38*	2.27	2.38*	2.27	4.08	4.08*	3.82	4.08*	3.75
MgO	1.46	1.36	1.48	1.42	1.50	2.36	2.28	2.26	2.29	2.24
Na ₂ O	15.81	16.40	15.35	16.18	15.60	8.92	9.45	8.78	9.50	8.60
NiO	0.01	<0.01	0.02	<0.01	0.02	0.01	<0.01	0.03	<0.01	0.03
P ₂ O ₅	0.12	0.17	0.31	0.17	0.26	0.12	0.19	0.35	0.18	0.38
PbO	0.01	0.01	0.02	<0.01	0.01	0.01	<0.01	0.01	<0.01	0.01
ReO ₂	0.10	<0.01	0.02	0.01	0.01	0.10	0.02	0.04	0.02	0.03
SiO ₂	44.21	44.40	41.44	45.00	41.36	46.75	47.79	43.72	48.01	43.26
SO ₃	0.53	0.29	NA	0.28	NA	0.69	0.33	NA	0.33	NA
TiO ₂	1.38	1.48	1.44	1.43	1.42	1.39	1.56	1.58	1.56	1.61
ZnO	3.45	3.28	3.38	3.13	3.37	3.47	3.01	3.39	2.99	3.40
ZrO ₂	2.95	3.17	2.92	3.00	2.99	2.97	2.91	2.95	2.90	2.91
Sum	100.00	100.00	95.20	100.00	96.63	100.00	100.00	94.83	100.00	94.51

* - Target values used for normalizing XRF data.

§ - Not a target constituent

NA – Not analyzed

Table 3.1. Summary of Test Conditions and Results for DM100 Correlation Tests.

Test		1A	1B	2A	2B	2C	2D	3A
Time	Feed Start	6/13/2005 12:00	6/15/2005 15:30	6/22/2005 6:30	6/23/2005 9:00	6/25/2005 12:06	6/27/2005 14:30	7/6/2005 6:30
	Feed End	6/15/2005 15:00	6/17/2005 18:00	6/23/2005 8:30	6/25/2005 11:30	6/27/2005 14:00	6/29/2005 19:15	7/7/2005 8:30
	Water Feeding (hr)	1.0	0.0	1.0	0.0	0.0	0.0	1.0
	Idling Time (hr)	0.0	0.9	0.0	0.4	0.4	2.5	0.0
	Net Slurry Feeding (hr)	50.0	49.6	25.0	50.1	49.5	50.3	25.0
	Cold Cap Burn-Off (hr)	NA	0.7	NA	NA	NA	1.5	NA
Feed	Simulant	AP-101	AN-105	AN-105	AN-107	AN-104	AN-102	AN-102
	Target Glass	LAW3	LAW4H without K	LAW4H	LAW5H	LAW6H	LAW7H	LAW7H
	Target wt% SO ₃	0.35	0.41	0.41	0.46	0.53	0.59	0.59
	Target wt% Na ₂ O	18.19	21.25	21.25	18.95	15.81	13.52	13.52
	Target wt% Cl	0.20	0.20	0.20	0.20	0.20	0.20	0.20
	Target wt% F	0.08	0.08	0.08	0.08	0.08	0.08	0.08
	Target Glass Yield (kg/kg)	0.533	0.491	0.488	0.482	0.499	0.478	0.478
	Used (kg)	851	913	461	941	902	908	462
Avg. Production Rate (kg/m ² /day)		1997	1990	1981	1993	2002	1900	1945
Avg. Bubbling Rate (lpm)		10.4	20.7	17.6	15.6	12.0	9.5	8.9
Sulfate Phases on Melt Surface	During Turnover	NA	No	NA	No	No	No	NA
	End of Segment	No	No	No	No	No	No	No
Product	Measured wt% SO ₃	0.33	0.36	0.36	0.43	0.45	0.54	0.51
	Measured wt% Cl	0.15	0.13	0.13	0.15	0.14	0.14	0.13
	Measured wt% F	< 0.08	< 0.08	< 0.08	< 0.08	< 0.08	< 0.08	< 0.08

NA – Not applicable

**Table 3.1. Summary of Test Conditions and Results for DM100 Correlation Tests
(continued).**

Test		3B	3C	4A	4B	4C	5A	5B
Time	Feed Start	7/7/2005 8:51	7/9/2005 11:36	8/15/2005 16:00	8/16/2005 10:00	8/18/2005 14:31	8/24/2005 6:30	8/25/2005 9:50
	Feed End	7/9/2005 11:00	7/11/2005 15:00	8/16/2005 8:30	8/18/2005 14:00	8/20/2005 18:00	8/25/2005 8:30	8/27/2005 13:30
	Water Feeding (hr)	NA	NA	1.0	NA	NA	1.0	NA
	Idling Time (hr)	0.4	1.2	0.0	3.2	2.2	0.2	1.7
	Net Slurry Feeding (hr)	49.8	50.2	15.5	48.8	49.3	24.8	50.0
	Cold Cap Burn-Off (hr)	NA	0.8	NA	NA	0.2	NA	NA
Feed	LAW Simulant	AZ-101	AZ-102	AZ-102	AZ-101	AN-102	AN-102	AN-104
	Target Glass	LAW9E9H	LAW9E10H	LAW9E10H	LAW9E9H	LAW9E7H	LAW9E7H	LAW9E6H
	Target wt% SO ₃	0.69	0.80	0.80	0.69	0.59	0.59	0.53
	Target wt% Na ₂ O	8.92	5.71	5.59	8.73	13.23	13.23	15.48
	Target wt% Cl	0.20	0.20	1.1	1.1	1.1	1.1	1.1
	Target wt% F	0.08	0.08	1.3	1.3	1.3	1.3	1.3
	Target Glass Yield (kg/kg)	0.526	0.538	0.519	0.524	0.476	0.476	0.497
	Used (kg)	853	833	276	865	905	484	914
Avg. Production Rate (kg/m ² /day)		1984	1966	2034	2045	1924	2045	2000
Avg. Bubbling Rate (lpm)		9.0	8.5	7.6	5.9	5.0	4.6	5.0
Sulfate Phases on Melt Surface	During Turnover	No	No	NA	Yes	Yes	NA	Yes
	End of Segment	No	No	Yes	No	Yes	Yes	No
Product	Measured wt% SO ₃	0.54	0.59	0.36	0.52	0.50	0.51	0.44
	Measured wt% Cl	0.13	0.13	0.41	0.67	0.63	0.55	0.63
	Measured wt% F	< 0.08	< 0.08	0.47	0.89	0.88	0.69	0.97

NA – Not applicable

**Table 3.1. Summary of Test Conditions and Results for DM100 Correlation Tests
(continued).**

Test		5C	5D	6A	6B
Time	Feed Start	8/27/2005 14:00	8/29/2005 17:45	9/12/2005 9:35	9/14/2005 13:45
	Feed End	8/29/2005 16:30	8/31/2005 20:30	9/14/2005 12:30	9/16/2005 16:30
	Water Feeding (hr)	NA	NA	0.9	NA
	Idling Time (hr)	0.6	0.7	0.0	0.6
	Net Slurry Feeding (hr)	49.9	50.1	50.0	50.2
	Cold Cap Burn-Off (hr)	NA	0.2	NA	ND
Feed	Simulant	AN-107	AN-105	AN-105	AP-101
	Target Glass	LAW5H	LAW4H	LAW4H without K	LAW3
	Target wt% SO ₃	0.46	0.41	0.41	0.35
	Target wt% Na ₂ O	18.55	20.68	20.80	17.81
	Target wt% Cl	1.1	1.1	1.1	1.1
	Target wt% F	1.3	1.3	1.3	1.3
	Target Glass Yield (kg/kg)	0.481	0.487	0.489	0.531
	Used (kg)	915	918	926	865
Avg. Production Rate (kg/m ² /day)		1942	1965	1994	2015
Avg. Bubbling Rate (lpm)		7.1	8.6	9.4	4.7
Sulfate Phases on Melt Surface	During Turnover	No	No	NA	No
	End of Segment	Yes	Yes	Yes	Yes
Product	Measured wt% SO ₃	0.41	0.34	0.34	0.33
	Measured wt% Cl	0.65	0.67	0.65	0.68
	Measured wt% F	0.94	0.98	0.97	0.98

NA – Not applicable

Table 3.2. Summary of Measured Melter Parameters for DM100 Correlation Tests.

Test			1A			1B			2A			2B			2C			2D		
			AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX
TEMPERATURE (C)	Electrode	East	1127	1107	1140	1125	1109	1155	1127	1109	1159	1129	1117	1139	1125	1113	1147	1129	1091	1148
		West	1071	1007	1088	1083	1063	1105	1088	1029	1106	1085	1070	1097	1075	1060	1090	1060	1029	1077
		Bottom	906	867	919	915	910	926	905	897	909	915	903	921	897	889	923	896	887	911
	Glass	19" from bottom	982	814	1036	1007	898	1082	1008	628	1086	982	872	1071	975	884	1034	928	789	1103
		16" from bottom	1134	1085	1169	1133	1109	1190	1134	924	1163	1131	1091	1160	1127	1101	1156	1120	1074	1168
		10" from bottom	1150	1112	1178	1151	1135	1196	1155	1126	1189	1150	1133	1185	1149	1128	1175	1148	1100	1174
		4" from bottom	1154	1112	1170	1153	1136	1191	1153	1121	1185	1153	1127	1180	1152	1123	1175	1150	1098	1169
	Plenum	Exposed	563	461	686	575	477	683	571	487	718	571	542	604	588	538	720	586	534	810
		Thermowell	555	531	667	563	528	643	567	520	709	548	528	574	566	545	628	575	535	768
	Discharge Chamber		1047	981	1071	1055	1016	1077	1046	1020	1067	987	957	1050	983	962	1018	976	948	1005
	Film Cooler Outlet		290	284	293	289	279	295	285	270	295	280	271	285	279	270	284	279	270	293
	Transition Line Outlet		285	271	311	289	279	297	282	272	307	279	268	284	276	271	283	276	267	289
Lance Bubbling (lpm)			10.4	1.5	11.6	20.7	1.6	28.0	17.6	1.6	25.7	15.6	1.5	17.1	12.0	1.6	15.1	9.5	1.6	13.1
Melter Pressure (inches water)			-0.99	-4.32	0.28	-0.96	-4.58	0.26	-1.06	-1.99	0.06	-0.85	-3.74	0.25	-0.83	-4.67	0.31	-0.87	-3.63	0.36
Electrode Voltage (V)			41.1	36.9	48.9	41.7	34.9	44.9	39.4	32.5	43.6	41.0	2.0	42.7	40.9	2.0	42.9	42.4	2.1	45.1
Total Power (kW)			21.5	19.7	30.9	22.3	17.9	23.9	21.9	16.8	26.9	23.6	0.3	24.4	22.3	0.3	23.9	23.1	0.3	25.0
Glass Pool Resistance (Ohms)			0.078	0.067	0.084	0.078	0.068	0.087	0.071	0.059	0.077	0.071	0.015	0.076	0.075	0.015	0.081	0.078	0.016	0.089

Table 3.2. Summary of Measured Melter Parameters for DM100 Correlation Tests (continued).

Test			3A			3B			3C			4A			4B			4C		
			AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX
TEMPERATURE (C)	Electrode	East	1127	1101	1136	1130	1113	1143	1132	1108	1143	1135	1113	1147	1137	1110	1148	1138	1108	1150
		West	1060	1029	1075	1053	1041	1066	1038	1026	1048	1050	1027	1065	1048	1015	1062	1048	1011	1063
		Bottom	888	880	894	901	890	914	908	895	921	919	898	932	905	897	920	899	889	906
	Glass	19" from bottom	879	707	969	891	787	987	886	718	1071	955	779	1139	967	796	1134	980	777	1140
		16" from bottom	1116	1076	1140	1115	1054	1157	1134	1072	1163	1134	1054	1165	1141	1078	1168	1143	1107	1165
		10" from bottom	1146	1100	1168	1147	1116	1165	1153	1127	1171	1153	1127	1172	1154	1112	1174	1154	1117	1170
		4" from bottom	1154	1107	1172	1154	1128	1174	1152	1129	1168	1144	1109	1163	1147	1107	1167	1145	1109	1161
	Plenum	Exposed	579	544	706	582	517	672	576	514	673	571	508	682	575	487	786	588	531	793
		Thermowell	577	550	708	557	432	641	544	504	619	578	522	693	568	506	751	570	534	758
	Discharge Chamber		972	941	1014	967	943	1000	964	944	995	972	938	1009	954	915	987	947	918	983
	Film Cooler Outlet		284	261	310	283	262	290	282	262	288	289	276	295	289	163	297	290	263	295
	Transition Line Outlet		280	276	310	278	260	287	276	260	287	275	266	280	274	176	294	271	254	291
Lance Bubbling (lpm)			8.9	1.5	10.1	9.0	1.6	27.9	8.5	1.5	26.7	7.6	2.1	11.2	5.9	1.6	15.0	5.0	1.6	7.1
Melter Pressure (inches water)			-1.03	-2.53	0.09	-1.02	-4.15	0.15	-1.05	-2.55	0.00	-1.21	-3.64	-0.10	-1.08	-4.12	0.12	-1.02	-4.56	0.11
Electrode Voltage (V)			43.9	39.9	47.0	47.9	2.0	55.5	54.4	2.0	59.4	56.5	51.7	59.2	50.4	2.0	58.0	45.1	2.0	52.6
Total Power (kW)			23.3	20.2	24.9	23.3	0.3	26.9	23.0	0.3	24.4	23.7	19.8	25.3	22.7	0.3	27.8	23.6	0.3	27.9
Glass Pool Resistance (Ohms)			0.083	0.077	0.089	0.099	0.015	0.122	0.129	0.015	0.149	0.135	0.126	0.149	0.112	0.015	0.137	0.086	0.015	0.111

Table 3.2. Summary of Measured Melter Parameters for DM100 Correlation Tests (continued).

Test			5A			5B			5C			5D			6A			6B		
			AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX
TEMPERATURE (C)	Electrode	East	1150	1089	1160	1150	1118	1158	1148	1126	1161	1146	1127	1162	1145	1108	1158	1145	1105	1154
		West	1071	1039	1082	1062	1034	1075	1069	1038	1086	1080	1042	1097	1087	1043	1104	1078	1034	1093
		Bottom	893	885	899	892	887	902	902	888	914	907	904	913	907	888	916	914	905	923
	Glass	19" from bottom	925	515	1052	956	829	1134	979	894	1050	994	866	1105	1027	928	1098	1003	887	1106
		16" from bottom	1114	1019	1170	1122	1041	1166	1130	1091	1163	1126	1088	1173	1132	1096	1174	1133	1080	1163
		10" from bottom	1153	1073	1178	1156	1118	1171	1155	1131	1173	1151	1125	1175	1151	1109	1172	1153	1119	1168
		4" from bottom	1145	1064	1159	1147	1107	1163	1151	1116	1166	1152	1117	1170	1153	1093	1167	1147	1112	1162
	Plenum	Exposed	565	519	686	570	521	775	536	497	679	551	487	745	558	508	699	582	530	751
		Thermowell	572	538	691	573	539	756	546	517	670	559	510	718	558	532	690	577	542	717
	Discharge Chamber		947	915	982	865	825	939	865	839	907	869	845	909	871	848	914	868	843	913
	Film Cooler Outlet		289	249	297	289	270	298	290	258	297	287	268	297	298	279	308	293	273	303
	Transition Line Outlet		279	252	320	273	258	281	276	258	289	279	239	292	283	215	293	278	224	294
	Lance Bubbling (lpm)		4.6	0.2	5.6	5.0	1.5	10.6	7.1	1.6	9.2	8.6	1.6	12.1	9.4	1.7	11.1	4.7	1.6	10.2
	Melter Pressure (inches water)		-1.00	-3.47	1.18	-0.95	-4.49	0.37	-0.96	-4.37	2.98	-1.00	-3.86	0.01	-0.94	-3.40	2.07	-0.89	-3.89	0.20
	Electrode Voltage (V)		42.7	39.6	47.3	40.2	2.0	46.5	40.4	2.1	43.1	37.5	2.0	44.0	37.2	34.2	40.7	36.8	2.1	39.1
	Total Power (kW)		23.8	21.0	25.0	23.3	0.3	28.0	24.0	0.3	26.4	22.8	0.3	28.0	22.7	19.5	23.5	21.3	0.3	23.9
	Glass Pool Resistance (Ohms)		0.077	0.072	0.098	0.069	0.015	0.080	0.068	0.016	0.073	0.062	0.014	0.071	0.061	0.058	0.071	0.064	0.016	0.070

Table 4.1. Listing of DM100 Glasses Discharged, Analysis Performed, Masses, Target and Measured SO₃ Concentrations.

Test	Date	Sample Name	Analysis	Mass (kg)	Cumulative Mass (kg)	SO ₃ wt %	
						Target	Measured
1A	6/13/05	WVZ-G-40A	-	-	-	0.35	-
		WVZ-G-40B	XRF	24.60	24.60		0.53
		WVZ-G-40C	-	-	-		-
		WVZ-G-41A	XRF	27.18	51.78		0.51
		WVZ-G-41B	-	-	-		-
		WVZ-G-41C	XRF	22.16	73.94		0.47
		WVZ-G-45A	-	-	-		-
	6/14/05	WVZ-G-45B	XRF	30.08	104.02		0.44
		WVZ-G-46A	-	-	-		-
		WVZ-G-46B	XRF	23.24	127.26		0.42
		WVZ-G-46C	-	-	-		-
		WVZ-G-46D	XRF	21.92	149.18		0.40
		WVZ-G-46E	-	-	-		-
		WVZ-G-48A	XRF	19.26	168.44		0.40
		WVZ-G-48B	-	-	-		-
		WVZ-G-48C	XRF	23.30	191.74		0.37
		WVZ-G-51A	-	-	-		-
		WVZ-G-51B	XRF	25.92	217.66		0.39
		WVZ-G-51C	-	-	-		-
		WVZ-G-51D	XRF	23.80	241.46		0.36
		WVZ-G-51E	-	-	-		-
		WVZ-G-56A	XRF	27.54	269.00		0.36
		WVZ-G-56B	-	-	-		-
	6/15/05	WVZ-G-56C	XRF	23.60	292.60		0.35
		WVZ-G-56D	-	-	-		-
		WVZ-G-58A	XRF	26.74	319.34		0.35
		WVZ-G-58B	-	-	-		-
		WVZ-G-58C	XRF	23.62	342.96		0.35
		WVZ-G-58D	-	-	-		-
		WVZ-G-61A	XRF	24.56	367.52		0.35
		WVZ-G-61B	-	-	-		-
		WVZ-G-61C	XRF	25.70	393.22		0.33
		WVZ-G-61D	XRF, PCT, TCLP, F, CCC	13.84	407.06		0.33
1B		WVZ-G-70A	-	-	-	0.41	-
		WVZ-G-70B	XRF	31.14	438.20		0.33
		WVZ-G-72A	-	-	-		-
		WVZ-G-72B	XRF	30.20	468.40		0.35
		WVZ-G-72C	-	-	-		-
		WVZ-G-74A	XRF	22.74	491.14		0.35
	6/16/05	WVZ-G-75A	-	-	-		-
		WVZ-G-75B	XRF	20.58	511.72		0.39

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Table 4.1. Listing of DM100 Glasses Discharged, Analysis Performed, Masses, Target and Measured SO₃ Concentrations (continued).

Test	Date	Sample Name	Analysis	Mass (kg)	Cumulative Mass (kg)	SO ₃ wt %	
						Target	Measured
1B	6/16/05	WVZ-G-76A	-	-	-	0.41	-
		WVZ-G-76B	XRF	20.54	532.26		0.33
		WVZ-G-76C	-	-	-		-
		WVZ-G-79A	XRF	21.08	553.34		0.36
		WVZ-G-80A	-	-	-		-
		WVZ-G-80B	XRF	20.32	573.66		0.35
		WVZ-G-80C	-	-	-		-
		WVZ-G-81A	XRF	20.06	593.72		0.36
		WVZ-G-81B	-	-	-		-
		WVZ-G-81C	XRF	23.80	617.52		0.34
		WVZ-G-86A	-	-	-		-
		WVZ-G-86B	XRF	21.82	639.34		0.36
		WVZ-G-87A	-	-	-		-
		WVZ-G-87B	XRF	18.82	658.16		0.35
		WVZ-G-87C	-	-	-		-
		WVZ-G-89A	XRF	23.24	681.40		0.36
		WVZ-G-89B	-	-	-		-
	6/17/05	WVZ-G-89C	XRF	16.78	698.18		0.35
		WVZ-G-90A	-	-	-		-
		WVZ-G-90B	XRF	26.64	724.82		0.37
		WVZ-G-90C	-	-	-		-
		WVZ-G-90D	XRF	27.48	752.30		0.35
		WVZ-G-95A	-	-	-		-
		WVZ-G-95B	XRF	22.20	774.50		0.35
		WVZ-G-95C	-	-	-		-
		WVZ-G-95D	XRF	22.26	796.76		0.35
		WVZ-G-96A	-	-	-		-
		WVZ-G-96B	XRF	20.72	817.48		0.34
		WVZ-G-96C	-	-	-		-
		WVZ-G-97A	XRF	25.86	843.34		0.37
		WVZ-G-97B	-	11.86	855.20		0.34
2A	6/22/05	WVZ-G-118A	-	-	-	0.41	-
		WVZ-G-119A	XRF	17.82	873.02		0.36
		WVZ-G-120A	-	-	-		-
		WVZ-G-120B	XRF	24.44	897.46		0.37
		WVZ-G-121A	-	-	-		-
		WVZ-G-121B	XRF	22.04	919.50		0.37
		WVZ-G-121C	-	-	-		-
		WVZ-G-121D	XRF	19.38	938.88		0.38
		WVZ-G-123A	-	-	-		-
		WVZ-G-123B	XRF	21.18	960.06		0.37

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Table 4.1. Listing of DM100 Glasses Discharged, Analysis Performed, Masses, Target and Measured SO₃ Concentrations (continued).

Test	Date	Sample Name	Analysis	Mass (kg)	Cumulative Mass (kg)	SO ₃ wt %	
						Target	Measured
2A	6/22/05	WVZ-G-123C	-	-	-	0.41	-
		WVZ-G-123D	XRF	22.74	982.80		0.36
		WVZ-G-126A	-	-	-		-
	6/23/05	WVZ-G-126B	XRF	25.18	1007.98		0.37
		WVZ-G-126C	-	-	-		-
		WVZ-G-126D	XRF	20.80	1028.78		0.36
		WVZ-G-129A	-	-	-		-
		WVZ-G-129B	XRF	22.66	1051.44		0.38
		WVZ-G-129C	-	-	-		-
		WVZ-G-129D	XRF	21.54	1072.98		0.36
2B	6/23/05	WVZ-G-139A	-	-	-	0.46	-
		WVZ-G-139B	XRF	24.18	1097.16		0.37
		WVZ-G-140A	-	-	-		-
		WVZ-G-140B	XRF	25.66	1122.82		0.36
		WVZ-G-140C	-	-	-		-
		WVZ-G-141A	XRF	26.88	1149.70		0.41
		WVZ-G-141B	-	-	-		-
		WVZ-G-143A	XRF	22.74	1172.44		0.41
	6/24/05	WVZ-G-143B	-	-	-		-
		WVZ-G-143C	XRF	27.96	1200.40		0.43
		WVZ-G-143D	-	-	-		-
		WVZ-G-147A	XRF	25.10	1225.50		0.40
		WVZ-G-147B	-	-	-		-
		WVZ-G-147C	XRF	23.36	1248.86		0.41
		WVZ-G-150A	-	-	-		-
		WVZ-G-150B	XRF	26.66	1275.52		0.44
		WVZ-G-151A	-	-	-		-
		WVZ-G-151B	XRF	23.60	1299.12		0.45
		WVZ-G-152A	-	-	-		-
		WVZ-G-152B	XRF	23.36	1322.48		0.42
		WVZ-G-152C	-	-	-		-
		WVZ-G-152D	XRF	26.32	1348.80		0.41
		WVZ-G-153A	-	-	-		-
		WVZ-G-153B	XRF	24.98	1373.78		0.44
		WVZ-G-153C	-	-	-		-
		WVZ-G-153D	XRF	21.84	1395.62		0.43
		AWV-G-5A	-	-	-		-
		AWV-G-5B	XRF	26.52	1422.14		0.40
	6/25/05	AWV-G-5C	-	-	-		-
		AWV-G-5D	XRF	24.22	1446.36		0.42
		AWV-G-6A	-	-	-		-
		AWV-G-6B	XRF	27.00	1473.36		0.43

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Table 4.1. Listing of DM100 Glasses Discharged, Analysis Performed, Masses, Target and Measured SO₃ Concentrations (continued).

Test	Date	Sample Name	Analysis	Mass (kg)	Cumulative Mass (kg)	SO ₃ wt %		
						Target	Measured	
2B	6/25/05	AWV-G-6C	-	-	-	0.46	-	
		AWV-G-6D	XRF	27.40	1500.76		0.44	
		AWV-G-14A	XRF, F	12.68	1513.44		0.43	
2C		6/25/05	AWV-G-16A	-	-	-	0.53	-
			AWV-G-21A	XRF	28.68	1542.12		0.44
			AWV-G-21B	-	-	-		-
			AWV-G-22A	XRF	26.92	1569.04		0.43
			AWV-G-22B	-	-	-		-
			AWV-G-22C	XRF	24.74	1593.78		0.44
			AWV-G-24A	-	-	-		-
	AWV-G-24B		XRF	27.28	1621.06	0.45		
	AWV-G-24C		-	-	-	-		
	AWV-G-27A		XRF	24.84	1645.90	0.44		
	6/26/05	AWV-G-27B	-	-	-	-		
		AWV-G-27C	XRF, DCP	23.28	1669.18	0.46		
		AWV-G-29A	-	-	-	-		
		AWV-G-29B	XRF, DCP	23.68	1692.86	0.46		
		AWV-G-30A	-	-	-	-		
		AWV-G-30B	XRF	26.04	1718.90	0.45		
		AWV-G-32A	-	-	-	-		
		AWV-G-32B	XRF	25.14	1744.04	0.45		
		AWV-G-35A	-	-	-	-		
		AWV-G-35B	XRF	23.92	1767.96	0.44		
		AWV-G-35C	-	-	-	-		
		AWV-G-35D	XRF	23.70	1791.66	0.45		
		AWV-G-36A	-	-	-	-		
		AWV-G-36B	XRF	25.16	1816.82	0.52		
		AWV-G-36C	-	-	-	-		
		6/27/05	AWV-G-36D	XRF	28.08	1844.90		0.46
			AWV-G-41A	-	-	-		-
			AWV-G-41B	XRF	24.62	1869.52		0.53
	AWV-G-42A		-	-	-	-		
	AWV-G-42B		XRF	27.14	1896.66	0.45		
AWV-G-42C	-		-	-	-			
AWV-G-42D	XRF		26.76	1923.42	0.47			
AWV-G-45A	-		-	-	-			
AWV-G-45B	XRF, DCP, F		26.46	1949.88	0.45			
2D			AWV-G-49A	-	-	-	0.59	-
		AWV-G-54A	XRF	29.28	1979.16	0.47		
		AWV-G-54B	-	-	-	-		
		AWV-G-54C	XRF	27.32	2006.48	0.48		

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Table 4.1. Listing of DM100 Glasses Discharged, Analysis Performed, Masses, Target and Measured SO₃ Concentrations (continued).

Test	Date	Sample Name	Analysis	Mass (kg)	Cumulative Mass (kg)	SO ₃ wt %	
						Target	Measured
2D	6/27/05	AWV-G-54D	-	-	-	0.59	-
		AWV-G-55A	XRF	25.48	2031.96		0.50
	6/28/05	AWV-G-56A	-	-	-		-
		AWV-G-60A	XRF	27.26	2059.22		0.49
		AWV-G-60B	-	-	-		-
		AWV-G-60C	XRF, DCP	28.84	2088.06		0.51
		AWV-G-61A	-	-	-		-
		AWV-G-61B	XRF	23.54	2111.60		0.51
		AWV-G-63A	-	-	-		-
		AWV-G-63B	XRF	29.10	2140.70		0.49
		AWV-G-63C	-	-	-		-
		AWV-G-67A	XRF	25.04	2165.74		0.52
		AWV-G-67B	-	-	-		-
		AWV-G-68A	XRF	23.66	2189.40		0.51
		AWV-G-68B	-	-	-		-
	6/29/05	AWV-G-70A	XRF	33.32	2222.72		0.51
		AWV-G-71A	-	-	-		-
		AWV-G-71B	XRF	25.22	2247.94		0.51
		AWV-G-71C	-	-	-		-
		AWV-G-71D	XRF	27.58	2275.52		0.52
		AWV-G-75A	-	-	-		-
		AWV-G-75B	XRF	26.48	2302.00		0.54
		AWV-G-75C	-	-	-		-
		AWV-G-76A	XRF	23.48	2325.48		0.52
		AWV-G-76B	-	-	-		-
		AWV-G-76C	XRF	25.04	2350.52		0.53
		AWV-G-76D	-	-	-		-
		AWV-G-78A	XRF, F, DCP, PCT, TCLP, CCC	24.86	2375.38		0.54
3A	7/6/05	AWV-G-98A	-	-	-		-
		AWV-G-98B	XRF	31.40	2406.78		0.45
		AWV-G-99A	-	-	-		-
		AWV-G-100A	XRF	21.28	2428.06		0.47
		AWV-G-100B	-	-	-		-
		AWV-G-100C	XRF	25.64	2453.70		0.48
		AWV-G-101A	-	-	-		-
		AWV-G-101B	XRF	27.58	2481.28		0.48
		AWV-G-101C	-	-	-		-
		AWV-G-106A	XRF	29.08	2510.36		0.49
		AWV-G-106B	-	-	-		-
	7/7/05	AWV-G-106C	XRF	23.64	2534.00		0.51
		AWV-G-106D	-	-	-		-
		AWV-G-106E	XRF	22.76	2556.76		0.51

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Table 4.1. Listing of DM100 Glasses Discharged, Analysis Performed, Masses, Target and Measured SO₃ Concentrations (continued).

Test	Date	Sample Name	Analysis	Mass (kg)	Cumulative Mass (kg)	SO ₃ wt %	
						Target	Measured
3A		AWV-G-108A	-	-	-	0.59	-
		AWV-G-108B	XRF	25.24	2582.00		0.51
		AWV-G-108C	-	-	-		-
		AWV-G-108D	XRF	15.82	2597.82		0.51
3B	7/7/05	AWV-G-117A	-	-	-	0.69	-
		AWV-G-118A	XRF	22.30	2620.12		0.52
		AWV-G-118B	-	-	-		-
		AWV-G-118C	XRF	28.10	2648.22		0.53
		AWV-G-119A	-	-	-		-
		AWV-G-121A	XRF	28.76	2676.98		0.54
		AWV-G-121B	-	-	-		-
		AWV-G-122A	XRF	25.16	2702.14		0.57
		AWV-G-122B	-	-	-		-
	7/8/05	AWV-G-125A	XRF	27.82	2729.96		0.57
		AWV-G-125B	-	-	-		-
		AWV-G-127A	XRF	25.10	2755.06		0.56
		AWV-G-127B	-	-	-		-
		AWV-G-128A	XRF	29.82	2784.88		0.55
		AWV-G-128B	-	-	-		-
		AWV-G-129A	XRF	22.28	2807.16		0.53
		AWV-G-129B	-	-	-		-
		AWV-G-129C	XRF	24.38	2831.54		0.52
		AWV-G-130A	-	-	-		-
		AWV-G-130B	XRF	28.96	2860.50		0.54
		AWV-G-135A	-	-	-		-
		AWV-G-135B	XRF	24.26	2884.76		0.54
		AWV-G-137A	-	-	-		-
		AWV-G-140A	XRF	26.72	2911.48		0.53
		AWV-G-140B	-	-	-		-
	7/9/05	AWV-G-140C	XRF	25.32	2936.80		0.52
		AWV-G-141A	-	-	-		-
		AWV-G-141B	XRF	24.72	2961.52		0.53
		AWV-G-142A	-	-	-		-
		AWV-G-142B	XRF	27.42	2988.94		0.52
		AWV-G-142C	-	-	-		-
		AWV-G-142D	XRF	25.02	3013.96		0.53
		AWV-G-147A	XRF, F, DCP	11.70	3025.66		0.54
3C		AWV-G-148A	-	-	-	0.80	-
		AWV-G-153A	XRF	26.12	3051.78		0.58
		AWV-G-153B	-	-	-		-
		AWV-G-153C	XRF	28.42	3080.20		0.57

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Table 4.1. Listing of DM100 Glasses Discharged, Analysis Performed, Masses, Target and Measured SO₃ Concentrations (continued).

Test	Date	Sample Name	Analysis	Mass (kg)	Cumulative Mass (kg)	SO ₃ wt %	
						Target	Measured
3C	7/9/05	AWV-G-153D	-	-	-	0.80	-
		AWV-G-155A	XRF	24.42	3104.62		0.56
		BWV-G-9A	-	-	-		-
	7/10/05	BWV-G-10A	XRF	25.32	3129.94		0.56
		BWV-G-10B	-	-	-		-
		BWV-G-10C	XRF	25.60	3155.54		0.57
		BWV-G-11A	-	-	-		-
		BWV-G-12A	XRF	24.62	3180.16		0.55
		BWV-G-12B	-	-	-		-
		BWV-G-12C	XRF	25.60	3205.76		0.58
		BWV-G-12D	-	-	-		-
		BWV-G-12E	XRF	23.30	3229.06		0.58
		BWV-G-14A	-	-	-		-
		BWV-G-14B	XRF	24.26	3253.32		0.58
		BWV-G-17A	-	-	-		-
		BWV-G-17B	XRF	27.48	3280.80		0.56
		BWV-G-19A	-	-	-		-
		BWV-G-19B	XRF	21.68	3302.48		0.58
		BWV-G-19C	-	-	-		-
		BWV-G-21A	XRF	26.54	3329.02		0.59
		BWV-G-24A	-	-	-		-
	7/11/05	BWV-G-24B	XRF	21.30	3350.32		0.57
		BWV-G-24C	-	-	-		-
		BWV-G-26A	XRF	27.52	3377.84		0.58
		BWV-G-26B	-	-	-		-
		BWV-G-27A	XRF	19.06	3396.90		0.55
		BWV-G-28A	-	-	-		-
		BWV-G-28B	XRF	29.74	3426.64		0.58
		BWV-G-32A	-	-	-		-
		BWV-G-32B	XRF,PCT,TCLP, CCC	23.38	3450.02		0.59
4A	8/15/05	BWV-G-58A	-	-	-	0.78	-
		BWV-G-59A	XRF, F	26.08	3476.10		0.11
		BWV-G-60A	-	-	-		-
		BWV-G-60B	XRF, F	23.14	3499.24		0.19
		BWV-G-61A	-	-	-		-
	8/16/05	BWV-G-61B	XRF, F	23.64	3522.88		0.25
		BWV-G-62A	-	-	-		-
		BWV-G-62B	XRF, F	21.16	3544.04		0.30
		BWV-G-66A	-	-	-		-
		BWV-G-66B	XRF, F	24.06	3568.10		0.34
		BWV-G-66C	XRF, CCC	12.00	3580.10		0.36

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Table 4.1. Listing of DM100 Glasses Discharged, Analysis Performed, Masses, Target and Measured SO₃ Concentrations (continued).

Test	Date	Sample Name	Analysis	Mass (kg)	Cumulative Mass (kg)	SO ₃ wt %	
						Target	Target
4B	3/16/05	BWV-G-71A	-	-	-	0.67	-
		BWV-G-71B	XRF, F	28.44	3608.54		0.39
		BWV-G-72A	-	-	-		-
		BWV-G-72B	XRF	25.72	3634.26		0.40
		BWV-G-73A	-	-	-		-
		BWV-G-73B	XRF, F	24.62	3658.88		0.42
		BWV-G-78A	-	-	-		-
		BWV-G-79A	XRF	27.20	3686.08		0.43
	8/17/05	BWV-G-79B	-	-	-		-
		BWV-G-81A	XRF, F	27.02	3713.10		0.45
		BWV-G-81B	-	-	-		-
		BWV-G-81C	XRF	26.08	3739.18		0.46
		BWV-G-81D	-	-	-		-
		BWV-G-84A	XRF, F	26.36	3765.54		0.48
		BWV-G-85A	-	-	-		-
		BWV-G-85B	XRF	28.42	3793.96		0.48
		BWV-G-86A	-	-	-		-
		BWV-G-88A	XRF, F	23.18	3817.14		0.49
		BWV-G-88B	-	-	-		-
		BWV-G-88C	XRF	26.10	3843.24		0.50
		BWV-G-89A	-	-	-		-
		BWV-G-89B	XRF	26.98	3870.22		0.51
		BWV-G-89C	-	-	-		-
		BWV-G-93A	XRF	26.48	3896.70		0.51
	8/18/05	BWV-G-93B	-	-	-		-
		BWV-G-93C	XRF	27.48	3924.18		0.51
		BWV-G-95A	-	-	-		-
		BWV-G-95B	XRF	26.94	3951.12		0.53
		BWV-G-98A	-	-	-		-
		BWV-G-98B	XRF	24.74	3975.86		0.51
		BWV-G-99A	-	-	-		-
		BWV-G-99B	XRF	25.42	4001.28		0.51
		BWV-G-102A	-	-	-		-
		BWV-G-102B	XRF, F	26.91	4028.19		0.52
4C		BWV-G-113A	-	-	-	0.58	-
		BWV-G-113B	XRF	26.66	4054.85		0.53
		BWV-G-113C	-	-	-		-
		BWV-G-113D	XRF	22.98	4077.83		0.49
		BWV-G-117A	-	-	-		-
		BWV-G-117B	XRF	26.58	4104.41		0.55

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Table 4.1. Listing of DM100 Glasses Discharged, Analysis Performed, Masses, Target and Measured SO₃ Concentrations (continued).

Test	Date	Sample Name	Analysis	Mass (kg)	Cumulative Mass (kg)	SO ₃ wt %	
						Target	Measured
4C	8/19/05	BWV-G-119A	-	-	-	0.58	-
		BWV-G-121A	XRF	25.78	4130.19		0.54
		BWV-G-121B	-	-	-		-
		BWV-G-124A	XRF	28.40	4158.59		0.46
		BWV-G-124B	-	-	-		-
		BWV-G-125A	XRF	28.48	4187.07		0.45
		BWV-G-125B	-	-	-		-
		BWV-G-126A	XRF	18.26	4205.33		0.45
		BWV-G-126B	-	-	-		-
		BWV-G-128A	XRF, F	30.34	4235.67		0.50
		BWV-G-128B	-	-	-		-
		BWV-G-128C	XRF	28.10	4263.77		0.43
		BWV-G-129A	-	-	-		-
		BWV-G-129B	XRF	20.44	4284.21		0.45
		BWV-G-129C	-	-	-		-
	8/20/05	BWV-G-129D	XRF	25.62	4309.83		0.45
		BWV-G-134A	-	-	-		-
		BWV-G-134B	XRF	24.76	4334.59		0.46
		BWV-G-134C	-	-	-		-
		BWV-G-136A	XRF	25.20	4359.79		0.46
		BWV-G-136B	-	-	-		-
		BWV-G-140A	XRF	23.86	4383.65		0.46
		BWV-G-140B	-	-	-		-
		BWV-G-141A	XRF	20.80	4404.45		0.46
		BWV-G-141B	-	-	-		-
		BWV-G-141C	XRF	25.98	4430.43		0.48
		BWV-G-142A	-	-	-		-
		BWV-G-142B	XRF, F, PCT, TCLP, CCC	24.40	4454.83		0.50
5A	8/24/05	CWV-G-8A	-	-	-		-
		CWV-G-8B	XRF, F	25.48	4480.31		0.47
		CWV-G-13A	-	-	-		-
		CWV-G-13B	XRF	25.18	4505.49		0.49
		CWV-G-15A	-	-	-		-
		CWV-G-15B	XRF	23.80	4529.29		0.48
		CWV-G-16A	-	-	-		-
		CWV-G-16B	XRF	24.06	4553.35		0.48
		CWV-G-16C	-	-	-		-
		CWV-G-16D	XRF	22.90	4576.25		0.48
		CWV-G-20A	-	-	-		-
		CWV-G-20B	XRF, F	29.20	4605.45		0.52

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Table 4.1. Listing of DM100 Glasses Discharged, Analysis Performed, Masses, Target and Measured SO₃ Concentrations (continued).

Test	Date	Sample Name	Analysis	Mass (kg)	Cumulative Mass (kg)	SO ₃ wt %	
						Target	Measured
5A	8/25/05	CWV-G-20C	-	-	-	0.58	-
		CWV-G-20D	XRF	24.60	4630.05		0.50
		CWV-G-22A	-	-	-		-
		CWV-G-22B	XRF	21.36	4651.41		0.51
		CWV-G-22C	-	-	-		-
		CWV-G-22D	XRF	23.20	4674.61		0.49
		CWV-G-26A	XRF, F	11.08	4685.69		0.51
5B	8/25/05	CWV-G-28A	-	-	-	0.52	-
		CWV-G-30A	XRF	24.30	4709.99		0.48
		CWV-G-30B	-	-	-		-
		CWV-G-30C	XRF	19.26	4729.25		0.46
		CWV-G-31A	-	-	-		-
		CWV-G-31B	XRF	29.74	4758.99		0.47
		CWV-G-35A	-	-	-		-
	8/26/05	CWV-G-35B	XRF	28.88	4787.87		0.46
		CWV-G-37A	-	-	-		-
		CWV-G-37B	XRF	21.86	4809.73		0.44
		CWV-G-37C	-	-	-		-
		CWV-G-38A	XRF	20.36	4830.09		0.44
		CWV-G-38B	-	-	-		-
		CWV-G-38C	XRF, F	22.36	4852.45		0.45
		CWV-G-43A	-	-	-		-
		CWV-G-43B	XRF	29.42	4881.87		0.47
		CWV-G-44A	-	-	-		-
		CWV-G-44B	XRF	20.24	4902.11		0.47
		CWV-G-45A	-	-	-		-
		CWV-G-45B	XRF	28.82	4930.93		0.46
		CWV-G-45C	-	-	-		-
		CWV-G-46A	XRF	21.60	4952.53		0.45
		CWV-G-46B	-	-	-		-
		CWV-G-46C	XRF	20.50	4973.03		0.45
		CWV-G-50A	-	-	-		-
		CWV-G-50B	XRF	19.50	4992.53		0.44
		CWV-G-50C	-	-	-		-
		CWV-G-50D	XRF, F	22.16	5014.69		0.46
	8/27/05	CWV-G-50E	-	-	-		-
		CWV-G-50F	XRF	20.14	5034.83		0.44
		CWV-G-52A	-	-	-		-
		CWV-G-52B	XRF	24.68	5059.51		0.43

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Table 4.1. Listing of DM100 Glasses Discharged, Analysis Performed, Masses, Target and Measured SO₃ Concentrations (continued).

Test	Date	Sample Name	Analysis	Mass (kg)	Cumulative Mass (kg)	SO ₃ wt %	
						Target	Measured
5B	3/27/05	CWV-G-53C	-	-	-	0.52	-
		CWV-G-54A	XRF	25.94	5085.45		0.42
		CWV-G-54B	-	-	-		-
		CWV-G-54C	XRF	23.62	5109.07		0.42
		CWV-G-54D	-	-	-		-
		CWV-G-58A	XRF	21.86	5130.93		0.43
		CWV-G-58B	XRF, F	12.56	5143.49		0.44
		CWV-G-60A	-	-	-	0.45	-
5C	3/27/05	CWV-G-61A	XRF	20.18	5163.67		0.43
		CWV-G-61B	-	-	-		-
		CWV-G-61C	XRF	23.62	5187.29		0.44
		CWV-G-63A	-	-	-		-
		CWV-G-63B	XRF	23.86	5211.15		0.44
		CWV-G-67A	-	-	-		-
		CWV-G-68A	XRF	25.82	5236.97		0.42
		CWV-G-68B	-	-	-		-
	8/28/05	CWV-G-69A	XRF	24.52	5261.49		0.42
		CWV-G-69B	-	-	-		-
		CWV-G-69C	XRF, F	19.90	5281.39		0.43
		CWV-G-69D	-	-	-		-
		CWV-G-71A	XRF	23.50	5304.89		0.42
		CWV-G-71B	-	-	-		-
		CWV-G-71C	XRF	20.98	5325.87		0.42
		CWV-G-71D	-	-	-		-
		CWV-G-72A	XRF	18.82	5344.69		0.42
		CWV-G-72B	-	-	-		-
		CWV-G-72C	XRF	23.52	5368.21		0.42
		CWV-G-75A	-	-	-		-
		CWV-G-75B	XRF	22.16	5390.37		0.41
		CWV-G-75C	-	-	-		-
		CWV-G-79A	XRF	25.04	5415.41		0.41
		CWV-G-79B	-	-	-		-
		CWV-G-79C	XRF	26.82	5442.23		0.43
		CWV-G-79D	-	-	-		-
	8/29/05	CWV-G-81A	XRF, F	21.86	5464.09		0.42
		CWV-G-81B	-	-	-		-
		CWV-G-81C	XRF	22.54	5486.63		0.42
		CWV-G-83A	-	-	-		-
		CWV-G-83B	XRF	20.80	5507.43		0.40
		CWV-G-83C	-	-	-		-
		CWV-G-86A	XRF	22.90	5530.33		0.41

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Table 4.1. Listing of DM100 Glasses Discharged, Analysis Performed, Masses, Target and Measured SO₃ Concentrations (continued).

Test	Date	Sample Name	Analysis	Mass (kg)	Cumulative Mass (kg)	SO ₃ wt %	
						Target	Measured
5C	3/29/05	CWV-G-86B	-	-	-	0.45	-
		CWV-G-86C	XRF	21.18	5551.51		0.41
		CWV-G-88A	-	-	-		-
		CWV-G-90A	XRF	20.94	5572.45		0.40
		CWV-G-90B	-	-	-		-
		CWV-G-90C	XRF, F, CCC	25.50	5597.95		0.41
5D	3/29/05	CWV-G-93A	-	-	-	0.40	-
		CWV-G-97A	XRF	26.54	5624.49		0.38
		CWV-G-97B	-	-	-		-
		CWV-G-97C	XRF	20.68	5645.17		0.38
		CWV-G-98A	-	-	-		-
		CWV-G-98B	XRF	19.82	5664.99		0.39
	8/30/05	CWV-G-99A	-	-	-		-
		CWV-G-100A	XRF	25.92	5690.91		0.39
		CWV-G-100B	-	-	-		-
		CWV-G-101A	XRF	21.30	5712.21		0.39
		CWV-G-101B	-	-	-		-
		CWV-G-105A	XRF	20.62	5732.83		0.37
		CWV-G-105B	-	-	-		-
		CWV-G-105C	XRF	21.58	5754.41		0.39
		CWV-G-107A	-	-	-		-
		CWV-G-107B	XRF, F	19.46	5773.87		0.37
		CWV-G-107C	-	-	-		-
		CWV-G-107D	XRF	22.32	5796.19		0.36
		CWV-G-109A	-	-	-		-
		CWV-G-109B	XRF	23.70	5819.89		0.36
		CWV-G-109C	-	-	-		-
	8/31/05	CWV-G-112A	XRF	24.21	5844.10		0.36
		CWV-G-112B	-	-	-		-
		CWV-G-112C	XRF	24.32	5868.42		0.34
		CWV-G-114A	-	-	-		-
		CWV-G-114B	XRF	19.60	5888.02		0.34
		CWV-G-114C	-	-	-		-
		CWV-G-114D	XRF, F	23.52	5911.54		0.36
		CWV-G-114E	-	-	-		-
		CWV-G-118A	XRF	21.52	5933.06		0.35
		CWV-G-118B	-	-	-		-
		CWV-G-118C	XRF	19.22	5952.28		0.33
		CWV-G-119A	-	-	-		-
		CWV-G-119B	XRF	20.82	5973.10		0.33

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Table 4.1. Listing of DM100 Glasses Discharged, Analysis Performed, Masses, Target and Measured SO₃ Concentrations (continued).

Test	Date	Sample Name	Analysis	Mass (kg)	Cumulative Mass (kg)	SO ₃ wt %	
						Target	Measured
5D	8/31/05	CWV-G-119C	-	-	-	0.40	-
		CWV-G-121A	XRF	20.34	5993.44		0.34
		CWV-G-121B	-	-	-		-
		CWV-G-121C	XRF	23.76	6017.20		0.33
		CWV-G-121D	-	-	-		-
		CWV-G-125A	XRF	19.04	6036.24		0.33
		CWV-G-125B	XRF, F, CCC	11.24	6047.48		0.34
6A	9/12/05	CWV-G-145A	-	-	-	0.40	-
		CWV-G-145B	XRF	20.62	6068.10		0.33
		CWV-G-146A	-	-	-		-
		CWV-G-147A	XRF	28.20	6096.30		0.35
		CWV-G-147B	-	-	-		-
		CWV-G-147C	XRF	27.16	6123.46		0.34
		CWV-G-149A	-	-	-		-
		CWV-G-149B	XRF	21.88	6145.34		0.35
		CWV-G-149C	-	-	-		-
	9/13/05	CWV-G-149D	XRF	23.30	6168.64		0.34
		CWV-G-152A	-	-	-		-
		CWV-G-152B	XRF	24.60	6193.24		0.35
		CWV-G-152C	-	-	-		-
		CWV-G-153A	XRF	24.74	6217.98		0.34
		CWV-G-153B	-	-	-		-
		CWV-G-153C	XRF	24.90	6242.88		0.35
		CWV-G-155A	-	-	-		-
		CWV-G-155B	XRF	23.34	6266.22		0.35
		CWV-G-155C	-	-	-		-
		DWV-G-6A	XRF	21.76	6287.98		0.35
		DWV-G-6B	-	-	-		-
		DWV-G-6C	XRF	19.62	6307.60		0.35
		DWV-G-10A	-	-	-		-
		DWV-G-10B	XRF	24.66	6332.26		0.35
		DWV-G-10C	-	-	-		-
		DWV-G-10D	XRF, F	20.36	6352.62		0.35
		DWV-G-11A	-	-	-		-
		DWV-G-11B	XRF	23.06	6375.68		0.36
	9/14/05	DWV-G-11C	-	-	-		-
		DWV-G-11D	XRF	25.78	6401.46		0.34
		DWV-G-15A	-	-	-		-
		DWV-G-15B	XRF	18.02	6419.48		0.35
		DWV-G-15C	-	-	-		-
		DWV-G-17A	XRF	22.22	6441.70		0.33

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Table 4.1. Listing of DM100 Glasses Discharged, Analysis Performed, Masses, Target and Measured SO₃ Concentrations (continued).

Test	Date	Sample Name	Analysis	Mass (kg)	Cumulative Mass (kg)	SO ₃ wt %	
						Target	Measured
6A		DWV-G-17B	-	-	-	0.40	-
		DWV-G-17C	XRF	20.94	6462.64		0.35
		DWV-G-19A	-	-	-		-
		DWV-G-19B	XRF, F	18.14	6480.78		0.35
		DWV-G-19C	XRF, CCC	11.68	6492.46		0.34
6B	9/14/05	DWV-G-23A	-	-	-	0.35	-
		DWV-G-23B	XRF	20.26	6512.72		0.33
		DWV-G-25A	-	-	-		-
		DWV-G-25B	XRF	24.00	6536.72		0.33
		DWV-G-25C	-	-	-		-
	9/15/0	DWV-G-25D	XRF	29.62	6566.34		0.33
		DWV-G-29A	-	-	-		-
		DWV-G-29B	XRF	24.48	6590.82		0.34
		DWV-G-29C	-	-	-		-
		DWV-G-29D	XRF, F	25.26	6616.08		0.33
		DWV-G-32A	-	-	-		-
		DWV-G-32B	XRF	21.24	6637.32		0.32
		DWV-G-32C	-	-	-		-
		DWV-G-33A	XRF	21.24	6658.56		0.31
		DWV-G-33B	-	-	-		-
		DWV-G-34A	XRF	18.84	6677.40		0.34
		DWV-G-34B	-	-	-		-
		DWV-G-34C	XRF	21.88	6699.28		0.32
		DWV-G-38A	-	-	-		-
		DWV-G-38B	XRF	26.32	6725.60		0.31
		DWV-G-39A	-	-	-		-
		DWV-G-39B	XRF, F	25.24	6750.84		0.32
		DWV-G-43A	-	-	-		-
		DWV-G-43B	XRF	23.88	6774.72		0.31
		DWV-G-43C	-	-	-		-
	9/16/05	DWV-G-43D	XRF	23.30	6798.02		0.30
		DWV-G-45A	-	-	-		-
		DWV-G-45B	XRF	30.32	6828.34		0.32
		DWV-G-45C	-	-	-		-
		DWV-G-46A	XRF	20.81	6849.15		0.31
		DWV-G-46B	-	-	-		-
		DWV-G-46C	XRF	25.68	6874.83		0.31
		DWV-G-48A	-	-	-		-
		DWV-G-48B	XRF	25.06	6899.89		0.32
		DWV-G-48C	-	-	-		-
		DWV-G-51A	XRF	26.92	6926.81		0.31
		DWV-G-51B	XRF,PCT,TCLP, CCC	10.80	6937.61		0.33

"-" Empty data field

Table 4.2. XRF Analyzed Compositions for Glass Samples Discharged During DM100 Tests (wt%).

Test	1A															
Glass (kg)		24.60	51.78	73.94	104.02	127.26	149.18	168.44	191.74	217.66	241.46	269.00	292.60	319.34	342.96	367.52
Constituent	Target	WVZ-G-40B	WVZ-G-41A	WVZ-G-41C	WVZ-G-45B	WVZ-G-46B	WVZ-G-46D	WVZ-G-48A	WVZ-G-48C	WVZ-G-51B	WVZ-G-51D	WVZ-G-56A	WVZ-G-56C	WVZ-G-58A	WVZ-G-58C	WVZ-G-61A
Al ₂ O ₃	6.09	7.18	6.96	6.66	6.57	6.58	6.32	6.40	6.25	6.28	6.15	6.16	6.10	6.26	6.17	5.96
B ₂ O ₃ *	9.99	10.63	10.50	10.42	10.32	10.26	10.22	10.18	10.15	10.12	10.10	10.07	10.06	10.05	10.04	10.03
CaO	2.02	3.68	3.32	3.04	2.87	2.76	2.79	2.63	2.45	2.52	2.33	2.17	2.23	2.15	2.14	2.20
CdO	§	0.09	0.08	0.06	0.06	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cl	0.20	0.18	0.18	0.17	0.17	0.17	0.16	0.16	0.16	0.15	0.16	0.16	0.16	0.16	0.15	0.17
Cr ₂ O ₃	0.08	0.47	0.42	0.38	0.36	0.34	0.35	0.33	0.30	0.32	0.29	0.26	0.27	0.26	0.26	0.27
F [#]	0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
Fe ₂ O ₃	5.49	4.17	4.38	4.38	4.59	4.79	5.09	5.06	4.92	4.99	5.11	4.78	5.12	5.03	4.99	5.39
K ₂ O	4.98	2.38	2.85	3.09	3.36	3.66	3.80	3.92	3.98	3.97	4.27	4.23	4.45	4.46	4.40	4.68
Li ₂ O*	§	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
MgO	1.48	1.31	1.33	1.36	1.39	1.37	1.40	1.43	1.45	1.44	1.43	1.52	1.41	1.48	1.52	1.44
Na ₂ O	18.19	19.00	19.00	19.20	18.99	18.31	18.26	17.94	18.83	18.78	18.68	18.94	18.56	18.04	18.85	18.21
NiO	0.01	0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
P ₂ O ₅	0.12	0.26	0.24	0.23	0.22	0.21	0.22	0.20	0.21	0.19	0.19	0.21	0.20	0.20	0.20	0.19
PbO	0.01	0.07	<0.01	0.01	0.01	0.01	<0.01	<0.01	<0.01	0.01	0.01	0.01	0.01	<0.01	0.01	0.01
ReO ₂	0.10	0.00	0.01	0.01	0.02	0.02	0.02	0.03	0.02	0.03	0.02	0.02	0.02	0.03	0.02	0.02
SiO ₂	42.91	41.97	41.92	42.40	42.17	42.46	41.83	42.26	42.23	42.08	42.31	43.34	42.72	43.60	43.03	42.71
SO ₃	0.35	0.53	0.51	0.47	0.44	0.42	0.40	0.40	0.37	0.39	0.36	0.36	0.35	0.35	0.35	0.35
TiO ₂	1.40	1.53	1.55	1.53	1.59	1.64	1.70	1.69	1.67	1.64	1.65	1.52	1.61	1.59	1.56	1.64
V ₂ O ₅	§	0.38	0.30	0.26	0.22	0.19	0.19	0.15	0.13	0.13	0.09	0.08	0.07	0.06	0.06	0.06
ZnO	3.50	3.00	3.04	2.98	3.10	3.19	3.40	3.35	3.21	3.27	3.25	2.95	3.19	3.08	3.02	3.28
ZrO ₂	3.00	3.23	3.40	3.35	3.54	3.61	3.84	3.87	3.68	3.70	3.59	3.21	3.45	3.21	3.22	3.40
Sum	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

* - Target values calculated based on simple well-stirred tank model;

- Fluorine values measured directly by XRF given in **bold**, other values interpolated between measured values.

§ Not a target component

Table 4.2. XRF Analyzed Compositions for Glass Samples Discharged During DM100 Tests (wt%) (continued).

Test	1A				1B											
Glass (kg)		393.22	407.06	407.06		438.20	468.40	491.14	511.72	532.26	553.34	573.66	593.72	617.52	639.34	658.16
Constituent	Target	WVZ-G-61C	WVZ-G-61D	%Dev.	Target	WVZ-G-70B	WVZ-G-72B	WVZ-G-74A	WVZ-G-75B	WVZ-G-76B	WVZ-G-79A	WVZ-G-80B	WVZ-G-81A	WVZ-G-81C	WVZ-G-86B	WVZ-G-87B
Al ₂ O ₃	6.09	6.25	6.00	-1.61	5.96	6.02	6.10	6.06	6.54	6.04	5.98	5.93	6.18	6.15	6.05	6.12
B ₂ O ₃ *	9.99	10.02	10.02	NC	9.78	9.96	9.92	9.90	9.88	9.86	9.85	9.84	9.83	9.82	9.81	9.81
CaO	2.02	2.30	2.16	7.09	2.46	2.15	2.19	2.27	2.37	2.27	2.31	2.32	2.31	2.31	2.39	2.34
CdO	§	<0.01	<0.01	NC	§	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cl	0.20	0.15	0.15	NC	0.20	0.15	0.15	0.14	0.11	0.13	0.14	0.14	0.13	0.14	0.13	0.13
Cr ₂ O ₃	0.08	0.32	0.27	NC	0.08	0.26	0.26	0.27	0.35	0.26	0.27	0.27	0.27	0.25	0.28	0.27
F [#]	0.08	<0.08	<0.08	NC	0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
Fe ₂ O ₃	5.49	5.36	5.45	-0.85	5.37	5.28	5.42	5.43	4.77	5.38	5.45	5.41	5.36	5.34	5.50	5.37
K ₂ O	4.98	4.48	4.78	-4.03	§	4.16	3.52	3.16	2.53	2.37	2.19	1.89	1.61	1.39	1.25	1.07
Li ₂ O*	§	<0.01	<0.01	NC	§	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
MgO	1.48	1.43	1.39	-5.68	1.45	1.46	1.43	1.46	1.47	1.45	1.47	1.44	1.53	1.45	1.44	1.46
Na ₂ O	18.19	18.40	18.27	0.41	21.25	18.94	18.97	18.71	19.70	19.76	19.56	20.25	20.12	20.59	20.06	20.85
NiO	0.01	0.01	0.00	NC	0.01	<0.01	<0.01	<0.01	0.02	0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01
P ₂ O ₅	0.12	0.18	0.18	NC	0.12	0.19	0.18	0.19	0.19	0.18	0.18	0.17	0.17	0.17	0.18	0.16
PbO	0.01	0.01	0.01	NC	0.01	<0.01	0.01	0.01	<0.01	0.01	0.01	0.01	0.01	<0.01	0.01	<0.01
ReO ₂	0.10	0.02	0.02	NC	0.10	0.02	0.02	0.03	0.02	0.03	0.03	0.03	0.03	0.04	0.04	0.03
SiO ₂	42.91	42.38	42.65	-0.61	44.99	43.04	43.34	43.78	44.41	43.90	44.19	44.00	44.27	44.19	44.36	44.19
SO ₃	0.35	0.33	0.33	-6.84	0.41	0.33	0.35	0.35	0.39	0.33	0.36	0.35	0.36	0.34	0.36	0.35
TiO ₂	1.40	1.62	1.63	16.82	1.37	1.59	1.59	1.60	1.41	1.56	1.56	1.54	1.53	1.52	1.56	1.51
V ₂ O ₅	§	0.07	0.04	NC	§	0.04	0.03	0.03	0.06	0.02	0.02	0.02	0.02	0.01	0.02	0.01
ZnO	3.50	3.24	3.28	-6.23	3.43	3.17	3.22	3.26	2.86	3.22	3.23	3.24	3.15	3.17	3.28	3.19
ZrO ₂	3.00	3.43	3.37	12.50	2.94	3.24	3.29	3.35	2.92	3.21	3.19	3.14	3.12	3.10	3.29	3.12
Sum	100.00	100.00	100.00	0.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

* - Target values calculated based on simple well-stirred tank model

- Fluorine values measured directly by XRF given in **bold**, other values interpolated between measured values.

NC – Not calculated

§ - Not a target component

Table 4.2. XRF Analyzed Compositions for Glass Samples Discharged During DM100 Tests (wt%) (continued).

Test	1B											2A				
Glass (kg)	681.40	698.18	724.82	752.30	774.50	796.76	817.48	843.34	855.20	855.20		873.02	897.46	919.50	938.88	
Constituent	Target	WVZ-G-89A	WVZ-G-89C	WVZ-G-90B	WVZ-G-90D	WVZ-G-95A	WVZ-G-95D	WVZ-G-96B	WVZ-G-97A	WVZ-G-97B	%Dev	Target	WVZ-G-119A	WVZ-G-120B	WVZ-G-121B	WVZ-G-121D
Al ₂ O ₃	5.96	6.35	5.96	6.00	5.95	5.88	6.15	5.98	5.92	6.20	4.52	5.93	6.15	6.10	6.14	6.12
B ₂ O ₃ *	9.78	9.80	9.80	9.80	9.79	9.79	9.79	9.79	9.79	9.79	NC	9.73	9.78	9.77	9.76	9.76
CaO	2.46	2.34	2.36	2.39	2.35	2.35	2.33	2.42	2.40	2.28	-6.88	2.44	2.49	2.42	2.39	2.44
CdO	§	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	NC	§	<0.01	<0.01	<0.01	<0.01
Cl	0.20	0.14	0.13	0.13	0.12	0.14	0.13	0.14	0.13	0.12	NC	0.20	0.07	0.08	0.09	0.10
Cr ₂ O ₃	0.08	0.25	0.26	0.27	0.26	0.26	0.25	0.26	0.25	0.24	NC	0.08	0.31	0.29	0.28	0.28
F [#]	0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	-NC	0.08	<0.08	<0.08	<0.08	<0.08
Fe ₂ O ₃	5.37	5.31	5.34	5.37	5.31	5.35	5.33	5.57	5.41	4.89	-8.43	5.35	5.25	5.03	5.07	5.22
K ₂ O	§	0.97	0.83	0.74	0.65	0.55	0.52	0.47	0.40	0.38	NC	0.54	0.47	0.47	0.48	0.51
Li ₂ O*	§	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	NC	§	<0.01	<0.01	<0.01	<0.01
MgO	1.45	1.51	1.50	1.48	1.47	1.49	1.49	1.53	1.54	1.52	5.17	1.44	1.46	1.52	1.46	1.48
Na ₂ O	21.25	20.41	20.90	20.85	21.25	21.30	21.03	20.72	21.25	21.41	1.29	21.13	21.39	21.93	22.46	21.38
NiO	0.01	<0.01	<0.01	0.01	0.01	<0.01	<0.01	<0.01	0.01	0.03	NC	0.01	0.02	0.01	0.01	0.01
P ₂ O ₅	0.12	0.17	0.18	0.17	0.17	0.17	0.17	0.18	0.17	0.17	NC	0.12	0.19	0.17	0.16	0.16
PbO	0.01	0.01	<0.01	<0.01	0.01	0.01	0.01	0.01	<0.01	0.01	NC	0.01	<0.01	0.01	<0.01	0.01
ReO ₂	0.10	0.03	0.04	0.02	0.04	0.04	0.04	0.04	0.03	0.03	NC	0.10	0.01	0.02	0.02	0.03
SiO ₂	44.99	44.51	44.52	44.69	44.64	44.66	44.80	44.60	44.53	45.75	2.23	44.75	44.44	44.52	44.09	44.55
SO ₃	0.41	0.36	0.35	0.37	0.35	0.35	0.35	0.34	0.37	0.34	NC	0.41	0.36	0.37	0.37	0.38
TiO ₂	1.37	1.50	1.51	1.51	1.48	1.47	1.48	1.51	1.50	1.39	2.44	1.36	1.46	1.43	1.42	1.46
V ₂ O ₅	§	0.01	0.01	0.01	<0.01	0.01	0.01	0.01	0.01	<0.01	NC	§	0.04	0.03	0.03	0.02
ZnO	3.43	3.16	3.16	3.16	3.15	3.13	3.11	3.25	3.17	2.81	-17.62	3.41	3.12	2.95	2.97	3.08
ZrO ₂	2.94	3.16	3.14	3.03	2.98	3.05	3.00	3.20	3.14	2.65	-9.38	2.92	3.00	2.90	2.80	3.01
Sum	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	NC	100.00	100.00	100.00	100.00	100.00

* - Target values calculated based on simple well-stirred tank model

- Fluorine values measured directly by XRF given in **bold**, other values interpolated between measured values.

NC – Not calculated

§ - Not a target component

Table 4.2. XRF Analyzed Compositions for Glass Samples Discharged During DM100 Tests (wt%) (continued).

Test	2A								2B							
Glass (kg)	960.06	982.80	1007.98	1028.78	1051.44	1072.98	1072.98		1097.16	1122.82	1149.70	1172.44	1200.40	1225.50	1248.86	
Constituent	Target	WVZ- G-123B	WVZ- G-123D	WVZ- G-126B	WVZ- G-126D	WVZ- G-129B	WVZ- G-129D	% Dev.	Target	WVZ- G-139B	WVZ- G-140B	WVZ- G-141A	WVZ- G-143A	WVZ- G-143C	WVZ- G-147A	WVZ- G-147C
Al ₂ O ₃	5.93	6.07	6.15	6.10	6.12	5.89	6.34	6.36	5.98	6.41	6.69	6.39	6.01	5.98	6.07	6.30
B ₂ O ₃ *	9.73	9.75	9.75	9.74	9.74	9.74	9.74	NC	9.80	9.75	9.76	9.77	9.77	9.78	9.78	9.79
CaO	2.44	2.49	2.39	2.35	2.41	2.47	2.41	-1.77	3.61	2.50	2.56	2.75	2.92	3.03	2.96	3.13
CdO	§	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	NC	§	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cl	0.20	0.11	0.11	0.12	0.13	0.14	0.13	NC	0.20	0.13	0.12	0.15	0.14	0.14	0.14	0.14
Cr ₂ O ₃	0.08	0.29	0.29	0.27	0.28	0.29	0.28	NC	0.08	0.26	0.24	0.25	0.25	0.25	0.23	0.21
F [#]	0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	NC	0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
Fe ₂ O ₃	5.35	5.36	5.18	5.04	5.27	5.44	5.26	-2.04	5.40	5.08	4.74	5.14	5.18	5.22	4.87	4.67
K ₂ O	0.54	0.52	0.54	0.56	0.58	0.56	0.57	NC	0.54	0.55	0.56	0.57	0.61	0.62	0.61	0.59
Li ₂ O*	§	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	NC	0.49	0.09	0.17	0.23	0.28	0.32	0.35	0.38
MgO	1.44	1.35	1.40	1.40	1.37	1.42	1.35	-6.88	1.45	1.39	1.42	1.41	1.33	1.42	1.43	1.42
Na ₂ O	21.13	21.18	21.27	21.79	21.39	21.54	20.98	-1.25	18.95	21.85	20.99	20.51	20.48	19.68	20.68	19.78
NiO	0.01	0.01	0.01	<0.01	0.01	0.01	0.01	NC	0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
P ₂ O ₅	0.12	0.17	0.17	0.17	0.16	0.18	0.16	NC	0.12	0.17	0.17	0.17	0.17	0.17	0.17	0.62
PbO	0.01	<0.01	0.01	0.01	0.01	0.01	<0.01	NC	0.01	0.01	<0.01	0.01	0.01	0.01	0.01	0.01
ReO ₂	0.10	0.03	0.03	0.03	0.04	0.04	0.03	NC	0.10	0.03	0.03	0.04	0.03	0.03	0.04	0.03
SiO ₂	44.75	44.68	44.78	44.81	44.59	44.17	44.67	-0.72	45.00	44.03	45.52	44.89	44.89	45.24	45.17	46.02
SO ₃	0.41	0.37	0.36	0.37	0.36	0.38	0.36	NC	0.46	0.37	0.36	0.40	0.40	0.43	0.40	0.41
TiO ₂	1.36	1.51	1.46	1.42	1.46	1.52	1.49	8.59	1.37	1.46	1.40	1.49	1.50	1.53	1.44	1.43
V ₂ O ₅	§	0.02	0.02	0.02	0.02	0.01	0.01	NC	§	0.01	0.01	0.01	0.01	0.01	0.01	0.01
ZnO	3.41	3.15	3.07	2.94	3.08	3.23	3.11	-9.21	3.43	3.02	2.71	2.98	3.02	3.10	2.88	2.68
ZrO ₂	2.92	2.93	3.01	2.87	2.98	2.97	3.10	5.48	2.94	2.91	2.55	2.83	2.97	3.04	2.75	2.39
Sum	100.00	100.00	100.00	100.00	100.00	100.00	100.00	NC	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

* - Target values calculated based on simple well-stirred tank model

- Fluorine values measured directly by XRF given in **bold**, other values interpolated between measured values.

NC – Not calculated

§ - Not a target component

Table 4.2. XRF Analyzed Compositions for Glass Samples Discharged During DM100 Tests (wt%) (continued).

Test	2B													2C		
Glass (kg)	1275.52	1299.12	1322.48	1348.80	1373.78	1395.62	1422.14	1446.36	1473.36	1500.76	1513.44	1513.44	1542.12	1569.04		
Constituent	Target	WVZ- G-150B	WVZ- G-151B	WVZ- G-152B	WVZ- G-152D	WVZ- G-153B	WVZ- G-153D	AWV- G-5B	AWV- G-5D	AWV- G-6B	AWV- G-6D	AWV- G-14A	%Dev.	Target	AWV- G-21A	AWV- G-22A
Al ₂ O ₃	5.98	5.85	5.84	5.84	5.91	5.77	5.97	5.88	5.93	5.81	5.82	5.81	-2.89	6.00	5.82	5.78
B ₂ O ₃ *	9.80	9.79	9.79	9.79	9.79	9.80	9.80	9.80	9.80	9.80	9.80	9.80	NC	9.84	9.81	9.81
CaO	3.61	3.13	3.27	3.26	3.32	3.32	3.19	3.36	3.28	3.34	3.43	3.39	-5.95	5.45	3.63	3.88
CdO	§	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	NC	§	<0.01	<0.01
Cl	0.20	0.15	0.15	0.14	0.15	0.15	0.14	0.15	0.14	0.15	0.15	0.14	NC	0.20	0.15	0.15
Cr ₂ O ₃	0.08	0.23	0.23	0.24	0.23	0.23	0.21	0.23	0.22	0.22	0.23	0.21	NC	0.08	0.22	0.22
F [#]	0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	NC	0.08	<0.08	<0.08
Fe ₂ O ₃	5.40	5.09	5.27	5.30	5.29	5.33	4.94	5.28	5.07	5.14	5.30	5.20	-3.69	5.41	5.22	5.25
K ₂ O	0.54	0.59	0.61	0.61	0.62	0.61	0.61	0.64	0.64	0.61	0.62	0.62	NC	0.54	0.61	0.61
Li ₂ O*	0.49	0.40	0.42	0.43	0.44	0.45	0.46	0.46	0.47	0.47	0.48	0.48	NC	2.38	0.88	1.18
MgO	1.45	1.47	1.45	1.51	1.41	1.44	1.37	1.37	1.37	1.37	1.34	1.45	-0.11	1.46	1.32	1.39
Na ₂ O	18.95	20.48	19.73	19.75	19.74	19.67	20.16	19.49	19.80	19.99	19.38	19.79	4.45	15.81	19.23	18.87
NiO	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	NC	0.01	<0.01	<0.01
P ₂ O ₅	0.12	0.18	0.17	0.17	0.18	0.18	0.18	0.17	0.19	0.17	0.18	0.18	NC	0.12	0.18	0.17
PbO	0.01	0.01	0.01	0.01	<0.01	<0.01	0.01	0.01	0.01	0.01	0.01	0.01	NC	0.01	0.01	0.01
ReO ₂	0.10	0.03	0.04	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.04	NC	0.10	0.03	0.03
SiO ₂	45.00	44.84	44.98	44.69	44.67	44.76	45.32	45.04	45.19	45.11	44.99	44.84	-0.35	44.21	44.83	44.56
SO ₃	0.46	0.44	0.45	0.42	0.41	0.44	0.43	0.40	0.42	0.43	0.44	0.43	NC	0.53	0.44	0.43
TiO ₂	1.37	1.52	1.57	1.56	1.56	1.57	1.48	1.56	1.52	1.55	1.58	1.57	14.36	1.38	1.54	1.53
V ₂ O ₅	§	0.01	0.01	<0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	NC	§	0.01	<0.01
ZnO	3.43	3.00	3.10	3.15	3.15	3.17	2.88	3.13	2.99	3.02	3.18	3.09	-9.89	3.45	3.10	3.11
ZrO ₂	2.94	2.80	2.93	3.08	3.08	3.05	2.82	3.00	2.93	2.78	3.02	2.94	0.21	2.95	2.97	3.03
Sum	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	NC	100.00	100.00	100.00

* - Target values calculated based on simple well-stirred tank model

- Fluorine values measured directly by XRF given in **bold**, other values interpolated between measured values.

NC – Not calculated

§ - Not a target component

Table 4.2. XRF Analyzed Compositions for Glass Samples Discharged During DM100 Tests (wt%) (continued).

Test	2C													
Glass (kg)		1593.78	1621.06	1645.9	1669.18	1692.86	1718.9	1744.04	1767.96	1791.66	1816.82	1844.9	1869.52	1896.66
Constituent	Target	AWV-G-22C	AWV-G-24B	AWV-G-27A	AWV-G-27C	AWV-G-29B	AWV-G-30B	AWV-G-32B	AWV-G-35B	AWV-G-35D	AWV-G-36B	AWV-G-36D	AWV-G-41B	AWV-G-42B
Al ₂ O ₃	6.00	5.90	5.84	5.80	5.87	5.83	5.85	5.82	5.82	5.80	5.96	5.99	5.94	6.03
B ₂ O ₃ *	9.84	9.82	9.82	9.83	9.83	9.83	9.83	9.83	9.84	9.84	9.84	9.84	9.84	9.84
CaO	5.45	4.03	4.25	4.38	4.56	4.56	4.59	4.66	4.84	4.90	4.81	4.91	4.72	4.85
CdO	§	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cl	0.20	0.14	0.13	0.13	0.14	0.14	0.14	0.13	0.13	0.13	0.13	0.13	0.13	0.14
Cr ₂ O ₃	0.08	0.21	0.21	0.21	0.20	0.20	0.20	0.19	0.20	0.20	0.19	0.20	0.19	0.20
F [#]	0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
Fe ₂ O ₃	5.41	5.15	5.22	5.23	5.32	5.23	5.16	5.10	5.30	5.24	5.05	5.10	4.82	5.03
K ₂ O	0.54	0.63	0.63	0.63	0.62	0.61	0.61	0.60	0.62	0.60	0.62	0.64	0.61	0.60
Li ₂ O*	2.38	1.41	1.60	1.75	1.86	1.95	2.04	2.10	2.15	2.19	2.23	2.26	2.28	2.30
MgO	1.46	1.36	1.41	1.38	1.37	1.43	1.45	1.35	1.39	1.39	1.30	1.39	1.43	1.44
Na ₂ O	15.81	18.36	17.73	17.99	17.53	17.94	17.92	17.96	17.32	17.55	17.10	17.03	17.13	17.28
NiO	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
P ₂ O ₅	0.12	0.18	0.19	0.18	0.18	0.18	0.16	0.17	0.17	0.18	0.17	0.18	0.17	0.18
PbO	0.01	0.01	<0.01	<0.01	0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01
ReO ₂	0.10	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
SiO ₂	44.21	44.80	44.85	44.47	44.23	44.15	44.06	44.14	44.00	44.06	44.76	44.50	45.26	44.52
SO ₃	0.53	0.44	0.45	0.44	0.46	0.46	0.45	0.45	0.44	0.45	0.52	0.46	0.53	0.45
TiO ₂	1.38	1.48	1.51	1.50	1.52	1.47	1.46	1.43	1.49	1.48	1.42	1.45	1.37	1.40
V ₂ O ₅	§	0.01	<0.01	<0.01	<0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	<0.01
ZnO	3.45	3.06	3.10	3.09	3.19	3.07	3.04	3.05	3.18	3.12	3.00	3.02	2.82	2.97
ZrO ₂	2.95	2.98	3.02	2.94	3.09	2.90	3.00	2.95	3.06	2.84	2.86	2.88	2.72	2.73
Sum	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

* - Target values calculated based on simple well-stirred tank model

- Fluorine values measured directly by XRF given in **bold**, other values interpolated between measured values.

NC – Not calculated

§ - Not a target component

Table 4.2. XRF Analyzed Compositions for Glass Samples Discharged During DM100 Tests (wt%) (continued).

Test	2C				2D											
Glass (kg)	1923.42	1949.88	1949.88		1979.16	2006.48	2031.96	2059.22	2088.06	2111.6	2140.7	2165.74	2189.4	2222.72	2247.94	
Constituent	Target	AWV-G-42D	AWV-G-45B	%Dev.	Target	AWV-G-54A	AWV-G-54C	AWV-G-55A	AWV-G-60A	AWV-G-60C	AWV-G-61B	AWV-G-63B	AWV-G-67A	AWV-G-68A	AWV-G-70A	AWV-G-71B
Al ₂ O ₃	6.00	5.92	5.86	-2.43	6.01	5.95	6.06	5.89	5.90	6.20	6.10	5.75	5.90	5.94	6.01	6.02
B ₂ O ₃ *	9.84	9.84	9.84	NC	9.86	9.84	9.85	9.85	9.85	9.85	9.85	9.86	9.86	9.86	9.86	9.86
CaO	5.45	4.98	5.01	-8.11	6.30	5.08	4.96	5.26	5.42	5.49	5.59	5.74	5.71	5.77	5.71	5.70
CdO	§	<0.01	<0.01	NC	§	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cl	0.20	0.13	0.14	NC	0.20	0.13	0.14	0.13	0.13	0.14	0.14	0.14	0.14	0.14	0.14	0.13
Cr ₂ O ₃	0.08	0.20	0.20	NC	0.08	0.20	0.19	0.20	0.20	0.20	0.20	0.21	0.20	0.20	0.20	0.20
F [#]	0.08	<0.08	<0.08	NC	0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
Fe ₂ O ₃	5.41	5.14	5.16	-4.78	5.42	5.16	4.82	5.12	5.20	5.23	5.31	5.51	5.40	5.40	5.24	5.24
K ₂ O	0.54	0.60	0.59	NC	0.54	0.61	0.61	0.64	0.63	0.62	0.62	0.63	0.62	0.65	0.66	0.66
Li ₂ O*	2.38	2.32	2.33	NC	3.17	2.51	2.64	2.74	2.83	2.90	2.95	3.00	3.03	3.05	3.08	3.10
MgO	1.46	1.45	1.54	5.31	1.49	1.48	1.55	1.46	1.42	1.50	1.45	1.47	1.51	1.44	1.51	1.56
Na ₂ O	15.81	17.13	16.96	7.22	13.52	16.50	16.40	15.78	15.40	15.49	14.86	14.93	14.41	14.36	14.83	14.37
NiO	0.01	<0.01	<0.01	NC	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01
P ₂ O ₅	0.12	0.18	0.18	NC	0.12	0.18	0.18	0.17	0.17	0.17	0.17	0.18	0.18	0.17	0.17	0.17
PbO	0.01	0.01	<0.01	NC	0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01
ReO ₂	0.10	0.02	0.02	NC	0.10	0.02	0.02	0.03	0.03	0.03	0.02	0.02	0.02	0.03	0.02	0.02
SiO ₂	44.21	44.28	44.31	0.23	44.71	44.40	45.26	44.92	44.86	44.29	44.61	44.09	44.85	44.73	44.54	45.02
SO ₃	0.53	0.47	0.45	NC	0.59	0.47	0.48	0.50	0.49	0.51	0.51	0.49	0.52	0.51	0.51	0.51
TiO ₂	1.38	1.42	1.43	3.74	1.38	1.45	1.35	1.43	1.47	1.48	1.50	1.54	1.51	1.51	1.49	1.48
V ₂ O ₅	§	0.01	<0.01	NC	§	0.01	0.01	0.01	0.01	0.01	0.01	<0.01	0.01	<0.01	0.01	0.01
ZnO	3.45	3.04	3.06	-11.16	3.46	3.06	2.81	3.01	3.07	3.12	3.15	3.29	3.14	3.22	3.10	3.08
ZrO ₂	2.95	2.86	2.92	-0.90	2.96	2.96	2.68	2.86	2.92	2.76	2.93	3.14	2.99	3.01	2.92	2.85
Sum	100.00	100.00	100.00	NC	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

* - Target values calculated based on simple well-stirred tank model

- Fluorine values measured directly by XRF given in **bold**, other values interpolated between measured values.

NC – Not calculated

§ - Not a target component

Table 4.2. XRF Analyzed Compositions for Glass Samples Discharged During DM100 Tests (wt%) (continued).

Test	2D							3A									
Glass (kg)	2275.52	2302	2325.48	2350.52	2375.38	2375.38		2406.78	2428.06	2453.7	2481.28	2510.36	2534	2556.76	2582	2597.82	2597.82
Constituent	Target	AWV- G-71D	AWV- G-75B	AWV- G-76A	AWV- G-76C	AWV- G-78A	%Dev	AWV- G-98B	AWV- G-100A	AWV- G-100C	AWV- G-101B	AWV- G-106A	AWV- G-106C	AWV- G-106E	AWV- G-108B	AWV- G-108D	%Dev.
Al ₂ O ₃	6.01	6.00	5.97	5.99	6.00	6.08	1.03	6.37	6.11	5.93	6.06	5.93	5.90	5.82	6.06	6.02	0.15
B ₂ O ₃ *	9.86	9.86	9.86	9.86	9.86	9.86	NC	9.86	9.86	9.86	9.86	9.86	9.86	9.86	9.86	9.86	NC
CaO	6.30	5.71	5.79	5.69	5.77	5.76	-8.63	6.02	5.93	6.02	6.07	5.99	5.96	6.04	5.75	6.09	-3.35
CdO	§	<0.01	<0.01	<0.01	<0.01	<0.01	NC	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	NC
Cl	0.20	0.13	0.14	0.14	0.13	0.14	NC	0.04	0.06	0.09	0.09	0.11	0.11	0.12	0.13	0.13	NC
Cr ₂ O ₃	0.08	0.22	0.20	0.19	0.20	0.19	NC	0.27	0.25	0.25	0.24	0.23	0.22	0.22	0.21	0.22	NC
F [#]	0.08	<0.08	<0.08	<0.08	<0.08	<0.08	NC	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	NC
Fe ₂ O ₃	5.42	5.23	5.22	5.22	5.23	5.20	-4.14	5.73	5.54	5.50	5.48	5.41	5.33	5.51	4.98	5.39	-0.68
K ₂ O	0.54	0.63	0.62	0.62	0.63	0.63	NC	0.66	0.65	0.65	0.68	0.67	0.67	0.67	0.65	0.66	NC
Li ₂ O*	3.17	3.11	3.12	3.13	3.14	3.14	NC	3.15	3.15	3.15	3.16	3.16	3.16	3.16	3.16	3.16	NC
MgO	1.49	1.54	1.54	1.67	1.59	1.58	6.04	1.49	1.52	1.52	1.44	1.47	1.48	1.37	1.46	1.43	-4.18
Na ₂ O	13.52	14.56	14.01	14.96	14.65	14.52	7.41	13.61	14.05	14.11	13.38	14.48	14.05	13.99	14.24	13.81	2.17
NiO	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	NC	0.03	0.02	0.01	0.01	0.01	0.01	<0.01	<0.01	<0.01	NC
P ₂ O ₅	0.12	0.18	0.19	0.18	0.18	0.19	NC	0.17	0.18	0.16	0.17	0.17	0.17	0.18	0.17	0.18	NC
PbO	0.01	<0.01	<0.01	0.01	<0.01	0.01	NC	<0.01	0.01	<0.01	0.01	0.01	<0.01	<0.01	0.01	<0.01	NC
ReO ₂	0.10	0.02	0.02	0.02	0.02	0.02	NC	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.03	0.02	NC
SiO ₂	44.71	44.80	45.35	44.48	44.64	44.81	0.23	43.84	44.02	44.02	44.73	43.96	44.63	44.42	45.39	44.37	-0.76
SO ₃	0.59	0.52	0.54	0.52	0.53	0.54	NC	0.45	0.47	0.48	0.48	0.49	0.51	0.51	0.51	0.51	NC
TiO ₂	1.38	1.50	1.49	1.47	1.49	1.48	7.69	1.60	1.58	1.59	1.58	1.56	1.55	1.57	1.47	1.57	13.70
V ₂ O ₅	§	0.01	0.01	<0.01	0.01	0.01	NC	0.02	0.01	0.02	0.02	0.01	0.01	0.01	0.01	0.01	NC
ZnO	3.46	3.09	3.05	3.01	3.09	3.03	-12.33	3.41	3.31	3.33	3.35	3.32	3.28	3.35	3.03	3.35	-2.95
ZrO ₂	2.96	2.89	2.86	2.85	2.84	2.80	-5.27	3.27	3.27	3.27	3.18	3.15	3.08	3.17	2.88	3.20	8.33
Sum	100.00	100.00	100.00	100.00	100.00	100.00	NC	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	NC

* - Target values calculated based on simple well-stirred tank model

- Fluorine values measured directly by XRF given in **bold**, other values interpolated between measured values.

NC – Not calculated

§ - Not a target component

Table 4.2. XRF Analyzed Compositions for Glass Samples Discharged During DM100 Tests (wt%) (continued).

Test	3B														
Glass (kg)		2620.12	2648.22	2676.98	2702.14	2729.96	2755.06	2784.88	2807.16	2831.54	2860.5	2911.48	2936.8	2961.52	2988.94
Constituent	Target	AWV- G-118A	AWV- G-118C	AWV- G-121A	AWV- G-122A	AWV- G-125A	AWV- G-127A	AWV- G-128A	AWV- G-129A	AWV- G-129C	AWV- G-130B	AWV- G-140A	AWV- G-140C	AWV- G-141B	AWV- G-142B
Al ₂ O ₃	6.05	6.58	6.93	6.49	5.98	5.84	5.86	5.85	6.01	6.22	6.25	6.32	6.58	6.20	6.04
B ₂ O ₃ *	9.91	9.87	9.88	9.88	9.89	9.89	9.90	9.90	9.90	9.90	9.90	9.91	9.91	9.91	9.91
CaO	6.85	5.97	6.09	6.24	6.11	6.47	6.19	6.57	6.22	6.30	6.33	6.15	6.28	6.24	6.55
CdO	§	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cl	0.20	0.13	0.14	0.14	0.13	0.14	0.14	0.14	0.13	0.13	0.13	0.13	0.12	0.13	0.14
Cr ₂ O ₃	0.08	0.22	0.21	0.21	0.19	0.21	0.18	0.20	0.18	0.19	0.18	0.17	0.17	0.17	0.18
F [#]	0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
Fe ₂ O ₃	5.44	5.30	5.36	5.39	5.13	5.63	5.24	5.71	5.25	5.27	5.20	5.02	5.24	5.06	5.43
K ₂ O	0.54	0.66	0.66	0.65	0.65	0.68	0.65	0.64	0.62	0.63	0.64	0.65	0.64	0.66	0.64
Li ₂ O*	4.08	3.32	3.48	3.60	3.69	3.77	3.83	3.88	3.92	3.95	3.97	4.01	4.02	4.03	4.04
MgO	2.36	1.40	1.58	1.64	1.91	1.92	2.08	2.11	2.22	2.23	2.20	2.24	2.22	2.28	2.31
Na ₂ O	8.92	13.66	12.48	11.76	12.06	10.81	11.27	11.18	10.92	10.55	10.34	9.70	10.06	10.15	9.90
NiO	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
P ₂ O ₅	0.12	0.18	0.18	0.17	0.18	0.19	0.18	0.18	0.17	0.17	0.17	0.18	0.17	0.18	0.18
PbO	0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01
ReO ₂	0.10	0.03	0.03	0.03	0.03	0.04	0.03	0.03	0.04	0.04	0.04	0.03	0.04	0.04	0.03
SiO ₂	46.75	44.28	44.48	45.19	45.88	45.43	46.12	44.83	46.18	46.28	46.46	47.88	46.37	47.08	46.12
SO ₃	0.69	0.52	0.53	0.54	0.57	0.57	0.56	0.55	0.53	0.52	0.54	0.53	0.52	0.53	0.52
TiO ₂	1.39	1.57	1.57	1.61	1.52	1.65	1.55	1.69	1.56	1.60	1.59	1.52	1.57	1.53	1.66
V ₂ O ₅	§	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	<0.01	0.01	<0.01	0.01	0.01	0.01
ZnO	3.47	3.25	3.28	3.29	3.08	3.41	3.14	3.41	3.12	3.15	3.10	2.95	3.12	2.97	3.26
ZrO ₂	2.97	3.05	3.11	3.15	2.97	3.32	3.04	3.12	3.01	2.86	2.95	2.62	2.94	2.84	3.07
Sum	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

* - Target values calculated based on simple well-stirred tank model

- Fluorine values measured directly by XRF given in **bold**, other values interpolated between measured values.

NC – Not calculated

§ - Not a target component

Table 4.2. XRF Analyzed Compositions for Glass Samples Discharged During DM100 Tests (wt%) (continued).

Test	3B				3C											
Glass (kg)	3013.96		3025.66	3025.66	3051.78		3080.2	3104.62	3129.94	3155.54	3180.16	3205.76	3229.06	3253.32	3280.8	3302.48
Constituent	Target	AWV-G-142D	AWV-G-147A	%Dev.	Target	AWV-G-153A	AWV-G-153C	AWV-G-155A	BWV-G-10A	BWV-G-10C	BWV-G-12A	BWV-G-12C	BWV-G-12E	BWV-G-14B	BWV-G-17B	BWV-G-19B
Al ₂ O ₃	6.05	6.44	6.29	3.95	6.06	5.94	6.02	6.34	6.02	6.22	6.47	6.35	6.21	6.08	6.28	6.34
B ₂ O ₃ *	9.91	9.91	9.91	NC	9.94	9.92	9.92	9.93	9.93	9.93	9.93	9.94	9.94	9.94	9.94	9.94
CaO	6.85	6.34	6.34	-7.50	6.95	6.49	6.48	6.24	6.58	6.26	6.53	6.50	6.46	6.51	6.39	6.11
CdO	§	<0.01	<0.01	NC	§	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cl	0.20	0.13	0.13	NC	0.20	0.14	0.14	0.13	0.13	0.12	0.13	0.14	0.13	0.13	0.13	0.13
Cr ₂ O ₃	0.08	0.17	0.18	NC	0.08	0.17	0.17	0.17	0.17	0.16	0.17	0.17	0.17	0.17	0.16	0.15
F [#]	0.08	<0.08	<0.08	NC	0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
Fe ₂ O ₃	5.44	5.26	5.25	-3.50	5.47	5.25	5.25	5.11	5.35	4.92	5.46	5.32	5.35	5.36	5.24	4.85
K ₂ O	0.54	0.64	0.65	NC	0.54	0.63	0.63	0.66	0.65	0.63	0.64	0.63	0.63	0.63	0.63	0.64
Li ₂ O*	4.08	4.05	4.05	NC	4.26	4.09	4.13	4.15	4.17	4.19	4.20	4.21	4.22	4.23	4.23	4.24
MgO	2.36	2.31	2.30	-2.51	2.94	2.44	2.50	2.49	2.59	2.78	2.77	2.82	2.88	2.91	3.11	3.07
Na ₂ O	8.92	9.90	9.81	9.97	5.71	9.18	9.10	8.18	8.13	7.87	7.22	7.29	7.02	7.13	7.05	7.10
NiO	0.01	<0.01	<0.01	NC	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
P ₂ O ₅	0.12	0.18	0.18	NC	0.12	0.19	0.20	0.18	0.18	0.20	0.18	0.19	0.19	0.19	0.18	0.19
PbO	0.01	<0.01	0.01	NC	0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
ReO ₂	0.10	0.04	0.04	NC	0.10	0.03	0.04	0.03	0.04	0.04	0.03	0.04	0.04	0.03	0.05	0.04
SiO ₂	46.75	46.43	46.58	-0.37	48.88	47.18	47.29	48.42	47.67	49.03	47.64	48.17	48.40	48.22	48.31	49.66
SO ₃	0.69	0.53	0.54	NC	0.80	0.58	0.57	0.56	0.56	0.57	0.55	0.58	0.58	0.58	0.56	0.58
TiO ₂	1.39	1.58	1.59	14.41	1.39	1.61	1.60	1.52	1.60	1.49	1.62	1.59	1.59	1.58	1.58	1.45
V ₂ O ₅	§	0.01	0.01	NC	§	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
ZnO	3.47	3.08	3.12	-9.91	3.48	3.13	3.11	3.02	3.19	2.89	3.29	3.16	3.20	3.22	3.16	2.86
ZrO ₂	2.97	2.99	3.03	2.15	2.99	3.01	2.84	2.84	3.04	2.69	3.14	2.92	2.98	3.09	3.00	2.65
Sum	100.00	100.00	100.00	NC	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

* - Target values calculated based on simple well-stirred tank model

- Fluorine values measured directly by XRF given in **bold**, other values interpolated between measured values.

NC – Not calculated

§ - Not a target component

Table 4.2. XRF Analyzed Compositions for Glass Samples Discharged During DM100 Tests (wt%) (continued).

Test	3C								4A								
Glass (kg)	3329.02	3350.32	3377.84	3396.9	3426.64	3450.02	3450.02		3476.1	3499.24	3522.88	3544.04	3568.1	3580.1	3580.10	3580.10	
Constituent	Target	BWV-G-21A	BWV-G-24B	BWV-G-26A	BWV-G-27A	BWV-G-28B	BWV-G-32B	%Dev.	Target	BWV-G-59A	BWV-G-60B	BWV-G-61B	BWV-G-62B	BWV-G-66B	BWV-G-66C	BWV-G-66C	%Dev.
Al ₂ O ₃	6.06	6.15	6.24	6.13	6.20	5.93	6.28	3.60	5.93	6.45	6.63	6.08	6.30	6.23	6.13	6.13	3.36
B ₂ O ₃ *	9.94	9.94	9.94	9.94	9.94	9.94	9.94	NC	9.73	9.90	9.87	9.85	9.83	9.81	9.80	9.80	NC
CaO	6.95	6.35	6.36	6.43	6.63	6.62	6.30	-9.44	6.80	6.54	6.59	6.63	6.49	6.57	6.35	6.35	-6.72
CdO	§	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	NC	§	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	NC
Cl	0.20	0.13	0.14	0.13	0.14	0.13	0.13	NC	1.10	0.05	0.17	0.27	0.32	0.38	0.41	0.41	NC
Cr ₂ O ₃	0.08	0.16	0.16	0.16	0.17	0.16	0.16	NC	0.08	0.16	0.16	0.16	0.16	0.16	0.16	0.16	NC
F [#]	0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	NC	1.30	0.08	0.18	0.29	0.35	0.44	0.47	0.47	NC
Fe ₂ O ₃	5.47	5.14	5.20	5.25	5.52	5.46	5.15	-5.95	5.36	5.33	5.47	5.50	5.37	5.39	5.19	5.19	-3.19
K ₂ O	0.54	0.64	0.66	0.66	0.66	0.63	0.66	NC	0.53	0.67	0.64	0.66	0.66	0.67	0.65	0.65	NC
Li ₂ O*	4.26	4.24	4.24	4.25	4.25	4.25	4.25	NC	4.17	4.23	4.22	4.21	4.20	4.20	4.19	4.19	NC
MgO	2.94	2.94	2.96	3.00	2.92	3.02	3.04	3.54	2.87	2.91	2.93	2.94	2.87	2.89	3.02	3.02	5.23
Na ₂ O	5.71	6.60	6.61	6.60	6.51	6.83	6.50	13.80	5.59	6.73	6.51	6.60	6.72	6.03	6.78	6.78	21.26
NiO	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	NC	0.01	0.01	0.01	0.01	0.01	0.01	<0.01	<0.01	NC
P ₂ O ₅	0.12	0.18	0.17	0.19	0.18	0.18	0.18	NC	0.12	0.19	0.18	0.17	0.18	0.18	0.18	0.18	NC
PbO	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	NC	0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	NC
ReO ₂	0.10	0.04	0.04	0.04	0.05	0.04	0.04	NC	0.10	<0.01	0.01	0.02	0.02	0.03	0.03	0.03	NC
SiO ₂	48.88	49.35	49.08	49.01	48.21	48.44	49.29	0.84	47.83	48.86	48.23	48.46	48.49	48.79	48.80	48.80	2.01
SO ₃	0.80	0.59	0.57	0.58	0.55	0.58	0.59	NC	0.78	0.11	0.19	0.25	0.30	0.34	0.36	0.36	NC
TiO ₂	1.39	1.52	1.55	1.56	1.61	1.60	1.51	8.82	1.36	1.58	1.63	1.63	1.57	1.59	1.53	1.53	12.63
V ₂ O ₅	§	0.01	0.01	0.01	0.01	0.01	0.01	NC	§	0.01	0.01	0.01	0.01	0.01	0.01	0.01	NC
ZnO	3.48	3.08	3.12	3.16	3.34	3.27	3.07	-11.76	3.40	3.08	3.19	3.20	3.12	3.17	3.03	3.03	-10.89
ZrO ₂	2.99	2.93	2.95	2.92	3.11	2.89	2.90	-3.02	2.92	3.11	3.16	3.06	3.02	3.12	2.89	2.89	-1.10
Sum	100.00	100.00	100.00	100.00	100.00	100.00	100.00	NC	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	NC

* - Target values calculated based on simple well-stirred tank model

- Fluorine values measured directly by XRF given in **bold**, other values interpolated between measured values.

NC – Not calculated

§ - Not a target component

Table 4.2. XRF Analyzed Compositions for Glass Samples Discharged During DM100 Tests (wt%) (continued).

Test	4B															
Glass (kg)		3608.54	3634.26	3658.88	3686.08	3713.10	3739.18	3765.54	3793.96	3817.14	3843.24	3870.22	3896.70	3924.18	3951.12	3975.86
Constituent	Target	BWV- G-66C	BWV- G-72B	BWV- G-73B	BWV- G-79A	BWV- G-81A	BWV- G-81C	BWV- G-84A	BWV- G-85B	BWV- G-88A	BWV- G-88C	BWV- G-89B	BWV- G-93A	BWV- G-93C	BWV- G-95B	BWV- G-98B
Al ₂ O ₃	5.92	6.08	6.11	6.01	6.14	5.96	5.99	6.05	6.32	6.15	6.01	5.80	5.87	5.86	5.95	5.92
B ₂ O ₃ *	9.70	9.78	9.77	9.75	9.74	9.74	9.73	9.72	9.72	9.72	9.71	9.71	9.71	9.71	9.71	9.70
CaO	6.71	6.49	6.45	6.57	6.42	6.59	6.48	6.53	6.36	6.41	6.51	6.45	6.43	6.44	6.33	6.46
CdO	§	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cl	1.10	0.42	0.46	0.51	0.52	0.57	0.59	0.61	0.63	0.62	0.67	0.66	0.65	0.64	0.65	0.64
Cr ₂ O ₃	0.08	0.17	0.16	0.16	0.16	0.17	0.17	0.17	0.17	0.16	0.17	0.17	0.17	0.17	0.17	0.17
F [#]	1.30	0.54	0.61	0.68	0.73	0.77	0.77	0.78	0.82	0.86	0.86	0.87	0.87	0.88	0.88	0.88
Fe ₂ O ₃	5.33	5.37	5.40	5.48	5.27	5.53	5.40	5.51	5.27	5.41	5.49	5.48	5.47	5.46	5.28	5.49
K ₂ O	0.53	0.66	0.64	0.66	0.65	0.64	0.64	0.66	0.62	0.62	0.62	0.63	0.64	0.64	0.62	0.63
Li ₂ O*	3.99	4.15	4.12	4.10	4.07	4.06	4.04	4.03	4.02	4.02	4.01	4.01	4.00	4.00	4.00	4.00
MgO	2.31	2.91	2.82	2.73	2.74	2.63	2.57	2.53	2.59	2.52	2.47	2.54	2.42	2.55	2.46	2.38
Na ₂ O	8.73	6.78	6.87	6.93	7.06	7.15	7.99	7.47	8.48	8.22	8.09	8.35	8.50	8.36	8.47	8.56
NiO	0.01	0.01	<0.01	0.01	0.00	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
P ₂ O ₅	0.12	0.18	0.18	0.17	0.19	0.18	0.17	0.18	0.19	0.18	0.19	0.19	0.19	0.19	0.18	0.18
PbO	0.01	<0.01	0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
ReO ₂	0.10	0.03	0.03	0.02	0.02	0.03	0.03	0.03	0.03	0.04	0.03	0.03	0.04	0.04	0.04	0.03
SiO ₂	45.75	48.21	48.19	47.88	48.23	47.65	47.15	47.28	46.85	46.78	46.75	46.78	46.64	46.76	47.15	46.55
SO ₃	0.67	0.39	0.40	0.42	0.43	0.45	0.46	0.48	0.48	0.49	0.50	0.51	0.51	0.51	0.53	0.51
TiO ₂	1.36	1.57	1.57	1.59	1.57	1.60	1.59	1.62	1.56	1.59	1.61	1.59	1.58	1.58	1.56	1.60
V ₂ O ₅	§	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
ZnO	3.39	3.17	3.12	3.22	3.05	3.21	3.15	3.22	3.03	3.15	3.20	3.17	3.17	3.12	3.05	3.16
ZrO ₂	2.90	3.09	3.09	3.08	3.00	3.05	3.06	3.11	2.84	3.03	3.10	3.05	3.12	3.07	2.98	3.11
Sum	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

* - Target values calculated based on simple well-stirred tank model

- Fluorine values measured directly by XRF given in **bold**, other values interpolated between measured values.

NC – Not calculated

§ - Not a target component

Table 4.2 XRF Analyzed Compositions for Glass Samples Discharged During DM100 Tests (wt%) (continued).

Test	4B				4C												
Glass (kg)		4001.28	4028.19	4028.19	4054.85		4077.83	4104.41	4130.19	4158.59	4187.07	4205.33	4235.67	4263.77	4284.21	4309.83	4334.59
Constituent	Target	BWV- G-99B	BWV- G-102B	%Dev.	Target	BWV- G-113B	BWV- G-113D	BWV- G-117B	BWV- G-121A	BWV- G-124A	BWV- G-125A	BWV- G-126A	BWV- G-128A	BWV- G-128C	BWV- G-129B	BWV- G-129D	BWV- G-134B
Al ₂ O ₃	5.92	5.99	5.87	-0.82	5.89	6.01	5.95	5.84	6.47	5.96	5.84	6.01	5.91	6.24	5.99	5.92	5.91
B ₂ O ₃ *	9.70	9.70	9.70	NC	9.65	9.69	9.69	9.68	9.67	9.67	9.67	9.66	9.66	9.66	9.66	9.66	9.66
CaO	6.71	6.44	6.54	-2.42	6.17	6.44	6.43	6.28	6.04	6.10	6.14	6.17	6.00	6.18	6.12	6.15	6.09
CdO	§	<0.01	<0.01	NC	§	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cl	1.10	0.65	0.67	NC	1.10	0.64	0.62	0.65	0.58	0.61	0.59	0.60	0.60	0.61	0.61	0.63	0.61
Cr ₂ O ₃	0.08	0.17	0.17	NC	0.08	0.17	0.17	0.17	0.18	0.17	0.17	0.17	0.18	0.18	0.18	0.19	0.19
F [#]	1.30	0.89	0.89	NC	1.30	0.88	0.88	0.87	0.87	0.86	0.85	0.85	0.84	0.85	0.85	0.85	0.86
Fe ₂ O ₃	5.33	5.46	5.57	4.52	5.31	5.44	5.43	5.23	5.04	5.10	5.21	5.29	5.11	5.49	5.36	5.43	5.43
K ₂ O	0.53	0.61	0.61	NC	0.53	0.61	0.65	0.62	0.60	0.62	0.61	0.62	0.61	0.61	0.60	0.61	0.64
Li ₂ O*	3.99	4.00	3.99	NC	3.10	3.82	3.69	3.57	3.48	3.40	3.34	3.30	3.26	3.23	3.21	3.19	3.17
MgO	2.31	2.51	2.44	5.64	1.46	2.37	2.09	1.97	1.92	1.81	1.76	1.68	1.73	1.57	1.60	1.57	1.47
Na ₂ O	8.73	8.73	8.36	-4.23	13.23	8.74	9.20	10.33	11.23	10.79	11.02	11.08	11.80	11.49	12.03	11.96	12.10
NiO	0.01	<0.01	<0.01	NC	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
P ₂ O ₅	0.12	0.19	0.18	NC	0.12	0.17	0.19	0.17	0.17	0.19	0.17	0.18	0.17	0.17	0.18	0.17	0.17
PbO	0.01	<0.01	<0.01	NC	0.01	0.01	0.01	<0.01	<0.01	0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01
ReO ₂	0.10	0.03	0.04	NC	0.10	0.03	0.02	0.02	0.02	0.03	0.01	0.01	0.02	0.02	0.03	0.02	0.02
SiO ₂	45.75	46.34	46.39	1.40	43.76	46.57	46.61	46.42	45.86	46.95	46.59	46.23	46.25	45.27	45.27	45.12	45.28
SO ₃	0.67	0.51	0.52	NC	0.58	0.53	0.49	0.55	0.54	0.46	0.45	0.45	0.50	0.43	0.45	0.45	0.46
TiO ₂	1.36	1.60	1.63	19.84	1.35	1.60	1.61	1.56	1.50	1.52	1.54	1.55	1.51	1.61	1.58	1.59	1.55
V ₂ O ₅	§	0.01	0.01	NC	§	0.01	<0.01	<0.01	0.02	0.01	0.01	<0.01	<0.01	<0.01	0.01	0.01	0.01
ZnO	3.39	3.14	3.22	-5.06	3.38	3.15	3.20	3.10	2.97	2.99	3.09	3.14	3.02	3.29	3.25	3.30	3.28
ZrO ₂	2.90	3.04	3.18	9.44	2.89	3.11	3.07	2.94	2.85	2.76	2.93	2.98	2.84	3.10	3.03	3.17	3.11
Sum	100.00	100.00	100.00	NC	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

* - Target values calculated based on simple well-stirred tank model

- Fluorine values measured directly by XRF given in **bold**, other values interpolated between measured values.

NC – Not calculated

§ - Not a target component

Table 4.2. XRF Analyzed Compositions for Glass Samples Discharged During DM100 Tests (wt%) (continued).

Test	4C							5A							
Glass (kg)		4359.79	4383.65	4404.45	4430.43	4454.83	4454.83	4480.31	4505.49	4529.29	4553.35	4576.25	4605.45	4630.05	4651.41
Constituent	Target	BWV-G-136A	BWV-G-140A	BWV-G-141A	BWV-G-141C	BWV-G-142B	%Dev.	CWV-G-8B	CWV-G-13B	CWV-G-15B	CWV-G-16B	CWV-G-16D	CWV-G-20B	CWV-G-20D	CWV-G-22B
Al ₂ O ₃	5.89	5.73	5.95	5.91	5.92	5.92	0.57	6.16	6.54	6.52	6.39	5.77	5.96	5.88	5.92
B ₂ O ₃ *	9.65	9.66	9.65	9.65	9.65	9.65	NC	9.65	9.65	9.65	9.65	9.65	9.65	9.65	9.65
CaO	6.17	6.09	5.88	5.94	5.72	5.82	-5.64	6.03	5.93	5.96	5.67	6.06	5.92	5.85	5.80
CdO	§	<0.01	<0.01	<0.01	<0.01	<0.01	NC	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cl	1.10	0.62	0.62	0.62	0.62	0.63	NC	0.24	0.31	0.41	0.44	0.49	0.52	0.52	0.54
Cr ₂ O ₃	0.08	0.19	0.18	0.18	0.18	0.18	NC	0.24	0.22	0.22	0.19	0.21	0.21	0.21	0.21
F [#]	1.30	0.86	0.87	0.87	0.88	0.88	NC	0.69	0.71	0.72	0.74	0.75	0.77	0.75	0.72
Fe ₂ O ₃	5.31	5.45	5.18	5.30	4.98	5.04	-5.06	5.28	5.32	5.41	4.84	5.55	5.33	5.23	5.15
K ₂ O	0.53	0.63	0.60	0.62	0.59	0.61	NC	0.58	0.60	0.59	0.59	0.63	0.63	0.62	0.61
Li ₂ O*	3.10	3.16	3.15	3.14	3.13	3.13	NC	3.12	3.12	3.11	3.11	3.11	3.11	3.11	3.10
MgO	1.46	1.48	1.49	1.49	1.58	1.53	5.04	1.57	1.55	1.52	1.53	1.49	1.50	1.50	1.49
Na ₂ O	13.23	12.33	12.63	12.50	13.07	12.34	-6.72	12.85	12.79	12.72	13.43	12.65	12.77	12.77	12.75
NiO	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	NC	0.02	0.02	0.01	0.01	0.01	0.01	0.01	<0.01
P ₂ O ₅	0.12	0.17	0.17	0.18	0.17	0.17	NC	0.17	0.17	0.17	0.18	0.17	0.17	0.17	0.18
PbO	0.01	<0.01	<0.01	<0.01	0.01	0.00	NC	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01
ReO ₂	0.10	0.03	0.02	0.02	0.02	0.02	NC	0.00	0.01	0.01	0.01	0.02	0.02	0.03	0.02
SiO ₂	43.76	45.19	45.74	45.57	45.84	46.42	6.08	45.54	44.89	44.84	45.90	44.90	45.19	45.67	45.99
SO ₃	0.58	0.46	0.46	0.46	0.48	0.50	NC	0.47	0.49	0.48	0.48	0.48	0.52	0.50	0.51
TiO ₂	1.35	1.58	1.49	1.53	1.44	1.47	9.08	1.53	1.53	1.55	1.45	1.56	1.53	1.51	1.47
V ₂ O ₅	§	0.01	0.01	0.01	0.01	0.01	NC	0.01	0.01	0.01	0.01	0.01	<0.01	0.01	0.01
ZnO	3.38	3.26	3.05	3.16	2.96	2.98	-11.82	3.09	3.16	3.23	2.83	3.29	3.15	3.10	3.00
ZrO ₂	2.89	3.12	2.85	2.87	2.75	2.69	-6.90	2.74	2.97	2.85	2.54	3.19	3.03	2.93	2.88
Sum	100.00	100.00	100.00	100.00	100.00	100.00	NC	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

* - Target values calculated based on simple well-stirred tank model

- Fluorine values measured directly by XRF given in **bold**, other values interpolated between measured values.

NC – Not calculated

§ - Not a target component

Table 4.2. XRF Analyzed Compositions for Glass Samples Discharged During DM100 Tests (wt%) (continued).

Test	5A				5B												
Glass (kg)		4674.61	4685.69	4685.69	4709.99		4729.25	4758.99	4787.87	4809.73	4830.09	4852.45	4881.87	4902.11	4930.93	4952.53	4973.03
Constituent	Target	CWV- G-22D	CWV- G-26A	%Dev.	Target	CWV- G-30A	CWV- G-30C	CWV- G-31B	CWV- G-35B	CWV- G-37B	CWV- G-38A	CWV- G-38C	CWV- G-43B	CWV- G-44B	CWV- G-45B	CWV- G-46A	CWV- G-46C
Al ₂ O ₃	5.89	5.91	5.85	-0.64	5.88	5.90	5.97	5.84	5.83	5.93	6.11	5.98	5.82	5.78	5.95	6.00	5.77
B ₂ O ₃ *	9.65	9.65	9.65	NC	9.63	9.65	9.65	9.64	9.64	9.64	9.64	9.64	9.64	9.64	9.63	9.63	9.63
CaO	6.17	5.96	5.89	-4.51	5.34	5.76	5.62	5.68	5.44	5.25	5.35	5.09	5.19	5.31	5.01	5.14	5.28
CdO	§	<0.01	<0.01	NC	§	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cl	1.10	0.54	0.55	NC	1.10	0.54	0.56	0.57	0.58	0.56	0.60	0.60	0.64	0.64	0.64	0.64	0.66
Cr ₂ O ₃	0.08	0.21	0.21	NC	0.08	0.20	0.20	0.21	0.23	0.20	0.21	0.19	0.20	0.20	0.19	0.20	0.21
F [#]	1.30	0.70	0.69	NC	1.30	0.72	0.75	0.79	0.83	0.86	0.89	0.92	0.92	0.92	0.92	0.91	0.91
Fe ₂ O ₃	5.31	5.36	5.24	-1.27	5.30	5.16	5.17	5.28	5.15	5.05	5.19	4.97	5.04	5.36	5.04	5.20	5.41
K ₂ O	0.53	0.60	0.61	NC	0.53	0.59	0.58	0.61	0.60	0.57	0.62	0.58	0.57	0.58	0.57	0.58	0.58
Li ₂ O*	3.10	3.10	3.10	NC	2.33	2.96	2.87	2.75	2.66	2.60	2.56	2.52	2.48	2.45	2.43	2.41	2.40
MgO	1.46	1.48	1.50	3.03	1.43	1.47	1.55	1.45	1.51	1.48	1.47	1.54	1.54	1.46	1.54	1.49	1.46
Na ₂ O	13.23	13.01	12.81	-3.16	15.48	13.97	14.31	13.94	14.69	15.23	14.36	14.85	14.36	14.57	14.96	14.84	14.68
NiO	0.01	0.01	<0.01	NC	0.01	<0.01	<0.01	0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
P ₂ O ₅	0.12	0.17	0.18	NC	0.12	0.17	0.16	0.17	0.17	0.15	0.17	0.18	0.18	0.17	0.17	0.17	0.17
PbO	0.01	0.01	<0.01	NC	0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.01	0.01	0.01	<0.01	<0.01	<0.01	0.01
ReO ₂	0.10	0.02	0.02	NC	0.10	0.02	0.02	0.02	0.02	0.03	0.02	0.03	0.03	0.03	0.02	0.03	0.02
SiO ₂	43.76	44.91	45.73	4.51	43.26	44.98	44.72	45.00	44.86	44.78	44.98	45.48	45.82	44.79	45.44	44.84	44.63
SO ₃	0.58	0.49	0.51	NC	0.52	0.48	0.46	0.47	0.46	0.44	0.44	0.45	0.47	0.47	0.46	0.45	0.45
TiO ₂	1.35	1.55	1.49	10.70	1.35	1.47	1.46	1.48	1.42	1.39	1.43	1.35	1.39	1.44	1.34	1.41	1.45
V ₂ O ₅	§	0.01	0.01	NC	§	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	<0.01	<0.01	0.01
ZnO	3.38	3.20	3.06	-9.56	3.37	3.05	3.03	3.12	3.03	2.95	3.03	2.86	2.90	3.13	2.89	3.04	3.17
ZrO ₂	2.89	3.10	2.88	-0.54	2.88	2.87	2.90	2.96	2.87	2.87	2.93	2.77	2.81	3.05	2.78	2.99	3.09
Sum	100.00	100.00	100.00	NC	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

* - Target values calculated based on simple well-stirred tank model

- Fluorine values measured directly by XRF given in **bold**, other values interpolated between measured values.

NC – Not calculated

§ - Not a target component

Table 4.2. XRF Analyzed Compositions for Glass Samples Discharged During DM100 Tests (wt%) (continued).

Test	5B										5C						
Glass (kg)		4992.53	5014.69	5034.83	5059.51	5085.45	5109.07	5130.93	5143.49	5143.49	5163.67		5187.29	5211.15	5236.97	5261.49	5281.39
Constituent	Target	CWV- G-50B	CWV- G-50D	CWV- G-50F	CWV- G-52B	CWV- G-54A	CWV- G-54C	CWV- G-58A	CWV- G-58B	%Dev.	Target	CWV- G-61A	CWV- G-61C	CWV- G-63B	CWV- G-68A	CWV- G-69A	CWV- G-69C
Al ₂ O ₃	5.88	5.91	5.88	5.98	5.88	5.94	5.82	5.82	5.78	-1.61	5.86	6.09	5.97	5.92	5.81	5.88	5.95
B ₂ O ₃ *	9.63	9.63	9.63	9.63	9.63	9.63	9.63	9.63	9.63	NC	9.59	9.63	9.62	9.62	9.61	9.61	9.61
CaO	5.34	5.14	5.13	5.01	4.99	5.06	5.13	5.14	5.07	-5.10	3.53	4.84	4.84	4.38	4.35	4.07	3.93
CdO	§	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	NC	§	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cl	1.10	0.63	0.65	0.62	0.61	0.61	0.62	0.64	0.63	NC	1.10	0.62	0.66	0.66	0.65	0.64	0.64
Cr ₂ O ₃	0.08	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	NC	0.08	0.19	0.21	0.19	0.20	0.20	0.18
F [#]	1.30	0.91	0.91	0.92	0.93	0.94	0.95	0.96	0.97	NC	1.30	0.97	0.98	0.98	0.99	1.00	1.00
Fe ₂ O ₃	5.30	5.30	5.29	5.17	5.28	5.36	5.32	5.37	5.29	-0.23	5.28	5.10	5.43	4.93	5.22	4.98	4.77
K ₂ O	0.53	0.59	0.60	0.61	0.59	0.59	0.60	0.57	0.57	NC	0.53	0.56	0.59	0.58	0.60	0.59	0.57
Li ₂ O*	2.33	2.39	2.38	2.37	2.36	2.35	2.35	2.35	2.34	NC	0.48	2.06	1.77	1.54	1.33	1.18	1.07
MgO	1.43	1.56	1.46	1.42	1.53	1.46	1.42	1.45	1.50	4.90	1.42	1.49	1.51	1.55	1.42	1.44	1.51
Na ₂ O	15.48	14.47	14.85	15.21	15.35	15.26	14.93	15.17	15.44	-0.27	18.55	15.54	15.51	16.51	16.67	17.55	17.66
NiO	0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	0.01	<0.01	NC	0.01	<0.01	0.01	<0.01	0.01	<0.01	<0.01
P ₂ O ₅	0.12	0.18	0.17	0.17	0.18	0.17	0.17	0.17	0.18	NC	0.12	0.16	0.18	0.18	0.16	0.16	0.17
PbO	0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	NC	0.01	<0.01	<0.01	<0.01	0.01	0.01	0.01
ReO ₂	0.10	0.03	0.02	0.02	0.03	0.03	0.03	0.03	0.02	NC	0.10	0.02	0.03	0.03	0.03	0.02	0.02
SiO ₂	43.26	45.13	44.85	44.91	44.60	44.40	44.80	44.35	44.46	2.77	44.04	45.06	44.50	45.50	45.08	45.18	45.76
SO ₃	0.52	0.44	0.46	0.44	0.43	0.42	0.42	0.43	0.44	NC	0.45	0.43	0.44	0.44	0.42	0.42	0.43
TiO ₂	1.35	1.40	1.39	1.39	1.38	1.39	1.41	1.43	1.40	3.64	1.34	1.39	1.46	1.36	1.43	1.38	1.34
V ₂ O ₅	§	0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	NC	§	<0.01	<0.01	<0.01	0.01	0.01	0.01
ZnO	3.37	3.08	3.10	2.99	3.03	3.11	3.12	3.16	3.05	-9.44	3.35	2.95	3.17	2.85	3.03	2.88	2.71
ZrO ₂	2.88	2.98	3.01	2.94	2.99	3.05	3.07	3.10	3.02	4.77	2.87	2.88	3.12	2.78	2.99	2.80	2.64
Sum	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	NC	100.00	100.00	100.00	100.00	100.00	100.00	100.00

* - Target values calculated based on simple well-stirred tank model

- Fluorine values measured directly by XRF given in **bold**, other values interpolated between measured values.

NC – Not calculated

§ - Not a target component

Table 4.2. XRF Analyzed Compositions for Glass Samples Discharged During DM100 Tests (wt%) (continued).

Test	5C															
Glass (kg)		5304.89	5325.87	5344.69	5368.21	5390.37	5410.61	5442.23	5464.09	5486.63	5507.43	5530.33	5551.51	5572.45	5597.95	5597.95
Constituent	Target	CWV- G-71A	CWV- G-71C	CWV- G-72A	CWV- G-72C	CWV- G-75B	CWV- G-79A	CWV- G-79C	CWV- G-81A	CWV- G-81C	CWV- G-83B	CWV- G-86A	CWV- G-86C	CWV- G-90A	CWV- G-90C	%Dev.
Al ₂ O ₃	5.86	5.97	5.90	5.92	5.78	5.70	5.79	5.99	5.83	5.90	6.11	6.00	5.94	5.95	5.83	-0.43
B ₂ O ₃ *	9.59	9.60	9.60	9.60	9.60	9.60	9.60	9.60	9.60	9.60	9.59	9.59	9.59	9.59	9.59	NC
CaO	3.53	4.12	4.06	4.01	3.82	3.81	3.75	3.57	3.52	3.38	3.45	3.34	3.49	3.42	3.38	-4.24
CdO	§	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	NC
Cl	1.10	0.66	0.66	0.68	0.67	0.68	0.66	0.66	0.66	0.67	0.64	0.64	0.66	0.65	0.65	NC
Cr ₂ O ₃	0.08	0.21	0.20	0.21	0.21	0.21	0.21	0.20	0.19	0.19	0.20	0.19	0.21	0.20	0.20	NC
F [#]	1.30	1.00	1.00	1.00	1.00	1.01	1.01	1.01	1.01	1.00	0.99	0.98	0.96	0.95	0.94	NC
Fe ₂ O ₃	5.28	5.29	5.37	5.47	5.22	5.36	5.33	5.02	5.03	4.80	5.14	4.84	5.18	5.13	5.03	-4.75
K ₂ O	0.53	0.60	0.61	0.59	0.59	0.58	0.59	0.61	0.60	0.57	0.61	0.58	0.61	0.58	0.58	NC
Li ₂ O*	0.48	0.96	0.89	0.83	0.77	0.72	0.68	0.63	0.61	0.59	0.57	0.55	0.54	0.53	0.52	NC
MgO	1.42	1.39	1.46	1.55	1.52	1.51	1.45	1.46	1.47	1.51	1.42	1.46	1.35	1.42	1.42	0.00
Na ₂ O	18.55	16.65	16.75	16.64	17.90	17.64	17.71	17.51	18.04	18.38	17.83	18.42	17.68	18.67	18.78	1.28
NiO	0.01	0.01	0.01	0.01	0.01	0.01	0.01	<0.01	<0.01	<0.01	0.01	<0.01	0.01	0.01	<0.01	NC
P ₂ O ₅	0.12	0.18	0.17	0.17	0.18	0.17	0.17	0.19	0.18	0.18	0.18	0.18	0.18	0.17	0.18	NC
PbO	0.01	0.01	0.01	0.01	0.01	0.01	0.01	<0.01	<0.01	<0.01	0.01	0.01	<0.01	0.01	0.01	NC
ReO ₂	0.10	0.03	0.03	0.03	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.03	0.03	0.03	NC
SiO ₂	44.04	45.30	45.14	44.93	44.73	44.81	44.90	45.95	45.61	45.99	45.57	45.91	45.79	44.92	45.25	2.74
SO ₃	0.45	0.42	0.42	0.42	0.42	0.41	0.41	0.43	0.42	0.42	0.40	0.41	0.41	0.40	0.41	NC
TiO ₂	1.34	1.48	1.50	1.53	1.47	1.52	1.52	1.44	1.44	1.41	1.46	1.39	1.48	1.49	1.44	7.44
V ₂ O ₅	§	<0.01	<0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	<0.01	0.01	<0.01	NC
ZnO	3.35	3.08	3.14	3.21	3.03	3.11	3.12	2.88	2.90	2.74	2.93	2.77	2.99	2.96	2.90	-13.59
ZrO ₂	2.87	3.04	3.10	3.18	3.04	3.09	3.04	2.82	2.84	2.66	2.86	2.69	2.91	2.92	2.85	-0.72
Sum	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	NC

* - Target values calculated based on simple well-stirred tank model

- Fluorine values measured directly by XRF given in **bold**, other values interpolated between measured values.

NC – Not calculated

§ - Not a target component

Table 4.2. XRF Analyzed Compositions for Glass Samples Discharged During DM100 Tests (wt%) (continued).

Test	5D																
Glass (kg)		5624.49	5645.17	5664.99	5690.91	5712.21	5732.83	5754.41	5773.87	5796.19	5819.89	5844.10	5868.42	5888.02	5911.54	5933.06	5952.28
Constituent	Target	CWV- G-97A	CWV- G-97C	CWV- G-98B	CWV- G-100A	CWV- G-101A	CWV- G-105A	CWV- G-105C	CWV- G-107B	CWV- G-107D	CWV- G-109B	CWV- G-112A	CWV- G-112C	CWV- G-114B	CWV- G-114D	CWV- G-118A	CWV- G-118C
Al ₂ O ₃	5.81	5.76	5.95	5.86	5.87	5.87	5.99	5.91	5.97	5.93	5.75	5.88	5.79	5.89	5.95	5.95	5.74
B ₂ O ₃ *	9.52	9.58	9.57	9.56	9.56	9.55	9.55	9.54	9.54	9.54	9.53	9.53	9.53	9.53	9.53	9.53	9.53
CaO	2.39	3.42	3.07	2.99	2.92	2.89	2.66	2.71	2.66	2.59	2.63	2.46	2.46	2.44	2.41	2.45	2.22
CdO	§	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cl	1.10	0.65	0.63	0.65	0.65	0.66	0.64	0.67	0.66	0.65	0.65	0.66	0.64	0.66	0.65	0.66	0.60
Cr ₂ O ₃	0.08	0.21	0.19	0.19	0.19	0.20	0.19	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.20
F [#]	1.30	0.95	0.96	0.97	0.98	0.99	0.99	1.00	1.01	1.01	1.00	1.00	1.00	0.99	0.99	0.99	0.99
Fe ₂ O ₃	5.23	5.36	4.78	4.86	4.84	5.04	4.80	5.06	5.23	5.06	5.28	4.88	5.05	5.04	4.90	5.22	4.75
K ₂ O	0.52	0.58	0.57	0.56	0.57	0.58	0.56	0.56	0.55	0.54	0.55	0.56	0.56	0.57	0.56	0.57	0.51
Li ₂ O*	§	0.42	0.35	0.30	0.24	0.20	0.17	0.14	0.12	0.10	0.08	0.07	0.05	0.05	0.04	0.03	0.03
MgO	1.41	1.45	1.47	1.49	1.53	1.46	1.60	1.49	1.50	1.57	1.51	1.46	1.46	1.50	1.50	1.49	1.57
Na ₂ O	20.68	18.29	19.85	19.39	19.65	19.31	20.33	19.59	19.80	20.48	20.00	20.24	20.28	20.14	20.13	19.77	23.47
NiO	0.01	0.01	<0.01	<0.01	<0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
P ₂ O ₅	0.12	0.17	0.17	0.17	0.17	0.18	0.17	0.17	0.17	0.17	0.17	0.17	0.16	0.16	0.18	0.16	0.15
PbO	0.01	0.01	0.01	0.01	<0.01	0.01	<0.01	0.01	0.01	0.01	<0.01	0.01	0.01	0.01	0.01	0.01	0.01
ReO ₂	0.10	0.04	0.03	0.03	0.03	0.03	0.03	0.02	0.04	0.04	0.04	0.03	0.04	0.03	0.04	0.03	0.03
SiO ₂	43.80	44.97	45.30	45.74	45.61	45.52	45.23	45.38	44.74	44.63	44.76	45.64	45.30	45.32	45.69	45.16	43.29
SO ₃	0.40	0.38	0.38	0.39	0.39	0.39	0.37	0.39	0.37	0.36	0.36	0.36	0.34	0.34	0.36	0.35	0.33
TiO ₂	1.33	1.53	1.36	1.38	1.37	1.42	1.34	1.41	1.43	1.40	1.44	1.33	1.37	1.37	1.37	1.41	1.28
V ₂ O ₅	§	0.01	0.01	0.01	<0.01	<0.01	0.01	0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01
ZnO	3.34	3.15	2.72	2.77	2.76	2.89	2.72	2.90	3.00	2.88	3.02	2.79	2.89	2.87	2.76	3.00	2.68
ZrO ₂	2.86	3.07	2.65	2.70	2.68	2.82	2.65	2.82	2.99	2.84	3.01	2.71	2.87	2.85	2.72	2.99	2.62
Sum	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

* - Target values calculated based on simple well-stirred tank model

- Fluorine values measured directly by XRF given in **bold**, other values interpolated between measured values.

NC – Not calculated

§ - Not a target component

Table 4.2. XRF Analyzed Compositions for Glass Samples Discharged During DM100 Tests (wt%) (continued).

Test	5D							6A									
Glass (kg)	5973.10	5993.44	6017.20	6036.24	6047.48	6047.48			6068.10	6096.30	6123.46	6145.34	6168.64	6193.24	6217.98	6242.88	6266.22
Constituent	Target	CWV- G-119B	CWV- G-121A	CWV- G-121C	CWV- G-125A	CWV- G-125B	%Dev.	Target	CWV- G-145B	CWV- G-147A	CWV- G-147C	CWV- G-149B	CWV- G-149D	CWV- G-152B	CWV- G-153A	CWV- G-153C	CWV- G-155B
Al ₂ O ₃	5.81	6.28	6.07	5.85	5.85	5.81	0.08	5.84	6.45	6.22	6.13	6.04	6.35	6.19	5.88	5.90	5.88
B ₂ O ₃ *	9.52	9.53	9.53	9.53	9.52	9.52	NC	9.57	9.53	9.54	9.55	9.55	9.56	9.56	9.56	9.56	9.57
CaO	2.39	2.41	2.42	2.31	2.38	2.30	-3.66	2.41	2.48	2.52	2.51	2.49	2.44	2.49	2.36	2.33	2.36
CdO	§	<0.01	<0.01	<0.01	<0.01	<0.01	NC	§	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cl	1.10	0.65	0.65	0.63	0.65	0.67	NC	1.10	0.15	0.26	0.39	0.44	0.47	0.52	0.56	0.57	0.58
Cr ₂ O ₃	0.08	0.22	0.22	0.20	0.22	0.21	NC	0.08	0.30	0.30	0.28	0.28	0.27	0.28	0.25	0.23	0.24
F [#]	1.30	0.99	0.98	0.98	0.98	0.98	NC	1.30	0.98	0.98	0.98	0.97	0.97	0.97	0.97	0.97	0.97
Fe ₂ O ₃	5.23	5.21	5.31	5.10	5.31	4.97	-4.93	5.26	5.25	5.47	5.45	5.48	5.38	5.47	5.21	5.06	5.21
K ₂ O	0.52	0.55	0.56	0.52	0.58	0.55	NC	§	0.50	0.44	0.38	0.33	0.33	0.33	0.28	0.24	0.22
Li ₂ O*	§	0.02	0.02	0.02	0.01	0.01	NC	§	0.01	0.01	0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01
MgO	1.41	1.55	1.54	1.59	1.56	1.57	11.56	1.42	1.55	1.53	1.60	1.57	1.53	1.48	1.52	1.59	1.56
Na ₂ O	20.68	19.91	19.98	21.88	19.99	20.58	-0.52	20.80	19.81	19.88	19.89	19.93	20.10	19.87	20.50	20.97	20.70
NiO	0.01	0.01	0.01	0.01	0.01	0.01	NC	0.01	0.05	0.04	0.04	0.03	0.03	0.03	0.02	0.02	0.02
P ₂ O ₅	0.12	0.15	0.16	0.16	0.16	0.17	NC	0.12	0.18	0.16	0.16	0.17	0.17	0.17	0.18	0.17	0.16
PbO	0.01	0.01	<0.01	0.01	0.01	<0.01	NC	0.01	0.01	0.01	0.01	<0.01	0.01	0.01	0.01	0.01	<0.01
ReO ₂	0.10	0.03	0.03	0.03	0.04	0.03	NC	0.10	0.01	0.02	0.02	0.03	0.02	0.03	0.03	0.03	0.03
SiO ₂	43.80	44.73	44.61	43.88	44.95	45.37	3.60	44.03	44.99	44.57	44.63	44.51	44.43	44.63	45.08	44.82	44.74
SO ₃	0.40	0.33	0.34	0.33	0.33	0.34	NC	0.40	0.33	0.35	0.34	0.35	0.34	0.35	0.34	0.35	0.35
TiO ₂	1.33	1.42	1.45	1.37	1.42	1.35	1.42	1.34	1.44	1.49	1.49	1.48	1.47	1.51	1.42	1.39	1.44
V ₂ O ₅	§	<0.01	<0.01	0.01	0.01	<0.01	NC	§	0.01	0.01	0.01	<0.01	<0.01	0.01	<0.01	0.01	<0.01
ZnO	3.34	2.98	3.05	2.90	3.07	2.82	-15.38	3.35	2.99	3.15	3.14	3.17	3.11	3.18	2.97	2.89	3.01
ZrO ₂	2.86	3.01	3.07	2.69	2.94	2.73	-4.55	2.87	2.98	3.05	3.00	3.17	3.03	2.93	2.85	2.86	2.97
Sum	100.00	100.00	100.00	100.00	100.00	100.00	NC	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

* - Target values calculated based on simple well-stirred tank model

- Fluorine values measured directly by XRF given in **bold**, other values interpolated between measured values.

NC – Not calculated

§ - Not a target component

Table 4.2. XRF Analyzed Compositions for Glass Samples Discharged During DM100 Tests (wt%) (continued).

Test		6A												6B			
Glass (kg)		6287.98	6307.60	6332.26	6352.62	6375.68	6401.46	6419.48	6441.70	6462.64	6480.78	6492.46	6492.46	6512.72		6536.72	6566.34
Constituent	Target	DWV-G-6A	DWV-G-6C	DWV-G-10B	DWV-G-10D	DWV-G-11B	DWV-G-11D	DWV-G-15B	DWV-G-17A	DWV-G-17C	DWV-G-19B	DWV-G-19C	%Dev.	Target	DWV-G-23B	DWV-G-25B	DWV-G-25D
Al ₂ O ₃	5.84	5.80	6.02	6.05	5.89	5.94	5.75	5.93	6.13	5.93	5.97	6.21	6.38	5.96	5.95	6.02	5.94
B ₂ O ₃ *	9.57	9.57	9.57	9.57	9.57	9.57	9.57	9.57	9.57	9.57	9.57	9.57	NC	9.78	9.60	9.64	9.67
CaO	2.41	2.38	2.40	2.32	2.30	2.30	2.34	2.29	2.41	2.35	2.36	2.35	-2.47	1.98	2.32	2.20	2.25
CdO	§	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	NC	§	<0.01	<0.01	<0.01
Cl	1.10	0.61	0.63	0.62	0.63	0.63	0.62	0.64	0.64	0.65	0.64	0.65	NC	1.10	0.64	0.65	0.65
Cr ₂ O ₃	0.08	0.24	0.24	0.22	0.23	0.22	0.23	0.22	0.23	0.23	0.22	0.22	NC	0.08	0.22	0.21	0.21
F [#]	1.30	0.97	0.97	0.96	0.96	0.96	0.96	0.97	0.97	0.97	0.97	0.97	NC	1.30	0.98	0.98	0.99
Fe ₂ O ₃	5.26	5.27	5.29	5.10	5.03	4.98	5.26	5.07	5.42	5.26	5.27	5.23	-0.65	5.38	5.15	4.97	5.18
K ₂ O	§	0.21	0.18	0.17	0.18	0.16	0.15	0.16	0.15	0.13	0.14	0.13	NC	4.87	0.56	1.12	1.44
Li ₂ O*	§	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	NC	§	<0.01	<0.01	<0.01
MgO	1.42	1.52	1.50	1.54	1.62	1.54	1.51	1.49	1.47	1.50	1.46	1.53	7.65	1.45	1.42	1.57	1.49
Na ₂ O	20.80	20.78	20.39	21.05	20.91	20.75	21.17	20.70	19.92	20.58	20.43	20.00	-3.82	17.81	20.40	19.92	19.92
NiO	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	NC	0.01	0.01	0.01	0.01
P ₂ O ₅	0.12	0.17	0.17	0.17	0.16	0.17	0.17	0.17	0.17	0.15	0.17	0.18	NC	0.12	0.17	0.18	0.18
PbO	0.01	0.01	<0.01	0.01	<0.01	<0.01	0.01	<0.01	0.01	0.01	<0.01	0.01	NC	0.01	<0.01	0.01	0.01
ReO ₂	0.10	0.04	0.03	0.03	0.03	0.03	0.04	0.04	0.04	0.04	0.04	0.04	NC	0.10	0.03	0.03	0.02
SiO ₂	44.03	44.61	44.77	44.68	45.07	45.39	44.46	45.27	44.86	44.76	44.92	45.27	2.81	42.00	44.88	45.26	44.56
SO ₃	0.40	0.35	0.35	0.35	0.35	0.36	0.34	0.35	0.33	0.35	0.35	0.34	NC	0.35	0.33	0.33	0.33
TiO ₂	1.34	1.43	1.46	1.42	1.38	1.37	1.43	1.39	1.48	1.45	1.45	1.43	6.75	1.37	1.45	1.39	1.44
V ₂ O ₅	§	0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.01	0.01	NC	§	0.01	0.01	0.01
ZnO	3.35	3.03	3.06	2.91	2.90	2.84	3.02	2.90	3.11	3.04	3.05	3.01	-10.16	3.42	2.99	2.83	2.96
ZrO ₂	2.87	3.00	2.94	2.80	2.78	2.77	2.94	2.84	3.07	2.99	2.97	2.84	-1.06	2.93	2.90	2.69	2.73
Sum	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	NC	100.00	100.00	100.00	100.00

* - Target values calculated based on simple well-stirred tank model

- Fluorine values measured directly by XRF given in **bold**, other values interpolated between measured values.

NC – Not calculated

§ - Not a target component

Table 4.2. XRF Analyzed Compositions for Glass Samples Discharged During DM100 Tests (wt%) (continued).

Test	6B																	
Glass (kg)	6590.82	6616.08	6637.32	6658.56	6677.40	6699.28	6725.60	6750.84	6774.72	6798.02	6828.34	6849.15	6874.83	6899.89	6926.81	6937.61	6937.61	
Constituent	Target	DWV-G-29B	DWV-G-29D	DWV-G-32B	DWV-G-33A	DWV-G-34A	DWV-G-34C	DWV-G-38B	DWV-G-39B	DWV-G-43B	DWV-G-43D	DWV-G-45B	DWV-G-46A	DWV-G-46C	DWV-G-48B	DWV-G-51A	DWV-G-51B	%Dev
Al ₂ O ₃	5.96	5.97	5.90	6.11	6.12	6.03	6.11	6.06	6.02	6.07	6.04	6.13	6.53	6.15	6.17	5.94	6.08	1.96
B ₂ O ₃ *	9.78	9.69	9.71	9.72	9.73	9.74	9.74	9.75	9.76	9.76	9.76	9.77	9.77	9.77	9.77	9.77	9.77	NC
CaO	1.98	2.12	2.21	2.22	2.17	2.18	2.09	2.08	2.08	2.04	2.06	2.01	2.07	2.08	1.96	2.02	2.05	3.91
CdO	§	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	NC
Cl	1.10	0.65	0.68	0.68	0.66	0.67	0.68	0.67	0.67	0.67	0.66	0.67	0.68	0.68	0.66	0.69	0.68	NC
Cr ₂ O ₃	0.08	0.21	0.22	0.22	0.21	0.24	0.21	0.20	0.21	0.20	0.21	0.20	0.21	0.21	0.20	0.21	0.21	NC
F [#]	1.30	0.99	1.00	1.00	0.99	0.99	0.99	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	NC
Fe ₂ O ₃	5.38	4.94	5.33	5.54	5.38	5.46	5.17	5.16	5.30	5.18	5.23	5.09	5.42	5.48	5.08	5.30	5.39	0.28
K ₂ O	4.87	2.02	2.50	2.96	3.18	3.38	3.56	3.74	3.90	4.11	4.16	4.23	4.39	4.50	4.39	4.56	4.62	-5.18
Li ₂ O*	§	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	NC
MgO	1.45	1.45	1.41	1.42	1.52	1.54	1.51	1.59	1.56	1.40	1.45	1.43	1.44	1.45	1.40	1.49	1.47	1.70
Na ₂ O	17.81	19.93	18.91	18.10	18.54	18.22	18.69	18.90	18.21	18.06	18.28	18.16	17.48	17.76	18.16	18.08	17.44	-2.04
NiO	0.01	<0.01	0.01	0.01	0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	<0.01	0.01	0.01	<0.01	0.01	0.01	NC
P ₂ O ₅	0.12	0.17	0.17	0.17	0.17	0.17	0.18	0.18	0.18	0.17	0.18	0.18	0.18	0.16	0.18	0.19	0.18	NC
PbO	0.01	<0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.01	<0.01	<0.01	<0.01	0.01	<0.01	0.01	0.01	0.01	NC
ReO ₂	0.10	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.02	0.02	0.02	0.02	NC
SiO ₂	42.00	44.67	44.32	43.87	43.60	43.51	44.00	43.46	43.68	44.05	43.69	44.13	43.18	43.07	44.04	43.35	43.62	3.87
SO ₃	0.35	0.34	0.33	0.32	0.31	0.34	0.32	0.31	0.32	0.31	0.30	0.32	0.31	0.31	0.32	0.31	0.33	NC
TiO ₂	1.37	1.38	1.48	1.53	1.50	1.51	1.43	1.44	1.47	1.45	1.46	1.44	1.48	1.51	1.41	1.48	1.49	9.17
V ₂ O ₅	§	<0.01	0.01	<0.01	0.01	0.01	0.01	<0.01	<0.01	0.01	0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	NC
ZnO	3.42	2.81	3.02	3.17	3.05	3.09	2.86	2.87	2.98	2.89	2.93	2.83	3.06	3.10	2.79	2.97	3.02	-11.69
ZrO ₂	2.93	2.64	2.77	2.94	2.81	2.90	2.42	2.57	2.67	2.62	2.57	2.42	2.76	2.75	2.46	2.62	2.61	-11.04
Sum	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	NC

* - Target values calculated based on simple well-stirred tank model

- Fluorine values measured directly by XRF given in **bold**, other values interpolated between measured values.

NC – Not calculated

§ - Not a target component

Table 4.3. Comparison of XRF and DCP Analyzed Compositions for Select Glass Samples (wt%).

Test	2C							2D					3B		
Constituent	Target	AWV-G-27C		AWV-G-29B		AWV-G-45B		Target	AWV-G-60C		AWV-G-78A		Target	AWV-G-147A	
		XRF	DCP	XRF	DCP	XRF	DCP		XRF	DCP	XRF	DCP		XRF	DCP
Al ₂ O ₃	6.00	5.87	6.06	5.83	6.35	5.86	6.34	6.01	6.20	6.19	6.08	6.28	6.05	6.29	6.28
B ₂ O ₃ *	9.84	9.83	9.74	9.83	9.27	9.84	9.21	9.86	9.85	9.19	9.86	9.22	9.91	9.91	9.27
CaO	5.45	4.56	4.65	4.56	4.86	5.01	5.34	6.30	5.49	5.80	5.76	6.23	6.85	6.34	6.85
Cl	0.20	0.14	NA	0.14	NA	0.14	NA	0.20	0.14	NA	0.14	NA	0.20	0.13	NA
Cr ₂ O ₃	0.08	0.20	0.19	0.20	0.19	0.20	0.20	0.08	0.20	0.19	0.19	0.19	0.08	0.18	0.17
F	0.08	<0.08	NA	<0.08	NA	<0.08	NA	0.08	<0.08	NA	<0.08	NA	0.08	<0.08	NA
Fe ₂ O ₃	5.41	5.32	4.90	5.23	4.75	5.16	4.74	5.42	5.23	4.78	5.20	4.79	5.44	5.25	4.73
K ₂ O	0.54	0.62	0.64	0.61	0.68	0.59	0.65	0.54	0.62	0.67	0.63	0.66	0.54	0.65	0.64
Li ₂ O*	2.38	1.86	1.89	1.95	1.98	2.33	2.18	3.17	2.90	2.65	3.14	2.99	4.08	4.05	3.96
MgO	1.46	1.37	1.48	1.43	1.51	1.54	1.56	1.49	1.50	1.57	1.58	1.62	2.36	2.30	2.36
Na ₂ O	15.81	17.53	16.03	17.94	16.63	16.96	15.59	13.52	15.49	14.09	14.52	13.18	8.92	9.81	9.42
NiO	0.01	<0.01	0.03	<0.01	0.03	<0.01	0.03	0.01	<0.01	0.03	<0.01	0.03	0.01	<0.01	0.03
P ₂ O ₅	0.12	0.18	0.30	0.18	0.29	0.18	0.31	0.12	0.17	0.22	0.19	0.25	0.12	0.18	0.32
PbO	0.01	0.01	0.02	0.01	0.02	<0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
ReO ₂	0.10	0.03	0.05	0.03	0.05	0.02	0.05	0.10	0.03	0.05	0.02	0.04	0.10	0.04	0.05
SiO ₂	44.21	44.23	42.35	44.15	41.66	44.31	41.51	44.71	44.29	41.73	44.81	41.82	46.75	46.58	42.62
SO ₃	0.53	0.46	NA	0.46	NA	0.45	NA	0.59	0.51	NA	0.54	NA	0.69	0.54	NA
TiO ₂	1.38	1.52	1.48	1.47	1.49	1.43	1.48	1.38	1.48	1.49	1.48	1.55	1.39	1.59	1.62
V ₂ O ₅	§	< 0.01	0.02	0.01	0.01	< 0.01	0.01	§	0.01	0.01	0.01	0.01	§	0.01	0.01
ZnO	3.45	3.19	3.35	3.07	3.28	3.06	3.31	3.46	3.12	3.36	3.03	3.46	3.47	3.12	3.42
ZrO ₂	2.95	3.09	2.85	2.90	2.94	2.92	2.96	2.96	2.76	2.94	2.80	2.97	2.97	3.03	3.03
Sum	100.00	100.00	96.03	100.00	95.99	100.00	95.49	100.00	100.00	94.97	100.00	95.30	100.00	100.00	94.79

* Target B and Li values used for normalizing XRF data calculated based on simple well-stirred tank model and the feed target composition

NA – Not analyzed

§ Not a target component

Table 4.4. Listing of Dip Samples Taken During DM100 Correlation Testing and Information on Secondary Phase.

Test	Sampling Date	Sample Name	Glass (kg)	Target (wt%)			Secondary Phase Observed
				SO ₃	F	Cl	
1A	6/13/05	WVZ-D-28A	0.00	0.35	0.08	0.20	No
	6/15/05	WVZ-D-65A	407.06				No
		WVZ-D-65B					No
		WVZ-D-65C					No
		WVZ-D-65D					No
		WVZ-D-65E					No
1B	6/16/05	WVZ-D-74A	491.14	0.41	0.08	0.20	No
		WVZ-D-74B					No
		WVZ-D-74C					Yes
		WVZ-D-74D					No
		WVZ-D-74E					No
	6/17/05	WVZ-D-97A	855.20				No
		WVZ-D-97B					No
		WVZ-D-97C					No
		WVZ-D-97D					No
		WVZ-D-97E					No
2A	6/22/05	WVZ-D-106A	1072.98	0.41	0.08	0.20	No
	6/23/05	WVZ-D-133A					No
		WVZ-D-133B					No
		WVZ-D-133C					No
		WVZ-D-133D					No
		WVZ-D-133E					No
2B	6/23/05	WVZ-D-141A	1149.70	0.46	0.08	0.20	No
		WVZ-D-141B					No
		WVZ-D-141C					No
		WVZ-D-141D					No
		WVZ-D-141E					No
	6/25/05	AWV-D-14A	1513.44				No
		AWV-D-14B					No
		AWV-D-14C					No
		AWV-D-14D					No
		AWV-D-14E					No
2C	6/25/05	AWV-D-22A	1593.78	0.53	0.08	0.20	No
		AWV-D-22B					No
		AWV-D-22C					No
		AWV-D-22D					No
		AWV-D-22E					No
	6/27/05	AWV-D-49A	1949.88				No
		AWV-D-49B					No
		AWV-D-49C					No
		AWV-D-49D					No
		AWV-D-49E					No
2D	6/27/05	AWV-D-55A	2031.96	0.59	0.08	0.20	No
		AWV-D-55B					No
		AWV-D-55C					No
		AWV-D-55D					No
		AWV-D-55E					No

Table 4.4 Listing of Dip Samples Taken During DM100 Correlation Testing and Information on Secondary Phase (continued).

Test	Sampling Date	Sample Name	Glass (kg)	Target (wt%)			Secondary Phase?						
				SO ₃	F	Cl							
2D	6/29/05	AWV-D-78A	2375.38	0.59	0.08	0.20	No						
		AWV-D-78B					No						
		AWV-D-78C					No						
		AWV-D-78D					No						
		AWV-D-78E					Yes						
3A	7/6/05	AWV-D-86A	2597.82				0.59	0.08	0.20	No			
	7/7/05	AWV-D-112A								No			
		AWV-D-112B								No			
		AWV-D-112C								No			
		AWV-D-112D								No			
		AWV-D-112E	No										
	7/7/05	AWV-D-121A	2676.98							0.59	0.08	0.20	No
		AWV-D-121B											No
		AWV-D-121C											No
		AWV-D-121D											No
		AWV-D-121E											No
3B	7/9/05	AWV-D-147A	3025.66	0.69	0.08	0.20	Yes						
		AWV-D-147B					No						
		AWV-D-147C					No						
		AWV-D-147D					No						
		AWV-D-147E					No						
		AWV-D-155A	3104.62				No						
		AWV-D-155B					No						
		AWV-D-155C					No						
		AWV-D-155D					No						
		AWV-D-155E					No						
3C	7/11/05	BWV-D-32A	3450.02	0.80	0.08	0.20	No						
		BWV-D-32B					No						
		BWV-D-32C					No						
		BWV-D-32D					No						
		BWV-D-32E					No						
4A	8/15/05	BWV-D-38A	3580.10	0.78	1.30	1.1	No						
	8/16/05	BWV-D-68A					Yes						
		BWV-D-68B					Yes						
		BWV-D-68C					Yes						
		BWV-D-68D					Yes						
		BWV-D-68E					Yes						
		BWV-D-68F					No						
		BWV-D-68G					No						
		BWV-D-68H					No						
		BWV-D-68I					No						
		BWV-D-68J					No						
4B		BWV-D-73A	3658.88	0.67	1.30	1.1	Yes						
		BWV-D-73B					Yes						
		BWV-D-73C					Yes						
		BWV-D-73D					Yes						
		BWV-D-73E					Yes						

Table 4.4. Listing of Dip Samples Taken During DM100 Correlation Testing and Information on Secondary Phase (continued).

Test	Sampling Date	Sample Name	Glass (kg)	Target (wt%)			Secondary Phase Observed	
				SO ₃	F	Cl		
4B	8/16/05	BWV-D-78A	3658.88	0.67	1.30	1.1	Trace Sulfate	
		BWV-D-78B					No	
		BWV-D-78C					No	
		BWV-D-78D					No	
		BWV-D-78E					No	
	8/18/05	BWV-D-102A	4028.19				No	
		BWV-D-102B					No	
		BWV-D-102C					No	
		BWV-D-102D					No	
		BWV-D-102E					No	
4C	8/18/05	BWV-D-118A	4104.41	0.58	1.30	1.1	Yes	
		BWV-D-118B					Yes	
		BWV-D-118C					Yes	
		BWV-D-118D					Yes	
		BWV-D-118E					Yes	
	8/19/05	BWV-D-118F					Yes	
		BWV-D-118G					Yes	
		BWV-D-118H					No	
		BWV-D-119A					No	
		BWV-D-119B					No	
		BWV-D-119C					No	
		BWV-D-119D					No	
		BWV-D-119E					No	
	8/20/05	BWV-D-142A					4454.83	Yes
		BWV-D-142B						Yes
		BWV-D-142C						Yes
		BWV-D-142D						No
		BWV-D-142E						Yes
		BWV-D-143A						Yes
		BWV-D-143B						No
BWV-D-143C		Yes						
BWV-D-143D		No						
5A	8/23/05	CWV-D-7A	4685.69	No				
	8/25/05	CWV-D-26A		No				
		CWV-D-26B		Yes				
		CWV-D-26C		No				
		CWV-D-26D		Yes				
		CWV-D-26E		No				
		CWV-D-27A		Yes				
		CWV-D-27B		No				
		CWV-D-27C		No				
		CWV-D-27D		No				
CWV-D-27E	No							

Table 4.4. Listing of Dip Samples Taken During DM100 Correlation Testing and Information on Secondary Phase (continued).

Test	Sampling Date	Sample Name	Glass (kg)	Target (wt%)			Secondary Phase Observed
				SO ₃	F	Cl	
5B	8/25/05	CWV-D-32A	4758.99	0.52	1.30	1.1	Yes
		CWV-D-32B					No
		CWV-D-32C					Yes
		CWV-D-32D					No
		CWV-D-32E					Yes
		CWV-D-32F					No
		CWV-D-32G					No
		CWV-D-32H					No
		CWV-D-32I					No
		CWV-D-32J					Trace
	8/27/05	CWV-D-58A	5143.49				No
		CWV-D-58B					No
		CWV-D-58C					No
		CWV-D-58D					No
		CWV-D-58E					No
5C	8/27/05	CWV-D-67A	5211.15	0.45	1.30	1.1	No
		CWV-D-67B					No
		CWV-D-67C					Trace
		CWV-D-67D					No
		CWV-D-67E					No
	8/29/05	CWV-D-92A	5597.95				No
		CWV-D-92B					Yes
		CWV-D-92C					Yes
		CWV-D-92D					Yes
		CWV-D-92E					No
		CWV-D-92F					No
		CWV-D-92G					No
		CWV-D-92H					No
		CWV-D-92I					No
		CWV-D-92J					No
5D	8/30/05	CWV-D-99A	5664.99	0.40	1.30	1.1	No
		CWV-D-99B					No
		CWV-D-99C					No
		CWV-D-99D					No
		CWV-D-99E					No
	8/31/05	CWV-D-125A	6047.48				No
		CWV-D-125B					Yes
		CWV-D-125C					Yes
		CWV-D-125D					No
		CWV-D-125E					Yes
		CWV-D-126A					No
		CWV-D-126B					No
		CWV-D-126C					No
		CWV-D-126D					No
		CWV-D-126E					No

Table 4.4. Listing of Dip Samples Taken During DM100 Correlation Testing and Information on Secondary Phase (continued).

Test	Sampling Date	Sample Name	Glass (kg)	Target (wt%)			Secondary Phase Observed			
				SO ₃	F	Cl				
6A	9/12/05	CWV-D-132A	6047.48	0.40	1.30	1.1	No			
	9/14/05	DWV-D-22A	6492.46				Yes			
		DWV-D-22B					Yes			
		DWV-D-22C					No			
		DWV-D-22D					No			
		DWV-D-22E					No			
		DWV-D-22F					No			
		DWV-D-22G					No			
		DWV-D-22H					No			
		DWV-D-22I					No			
		DWV-D-22J					No			
		6B					DWV-D-28A	6566.34	0.35	1.30
	DWV-D-28B		No							
DWV-D-28C	No									
DWV-D-28D	No									
DWV-D-28E	No									
9/16/05	DWV-D-52A		6937.61	Yes						
	DWV-D-52B			Yes						
	DWV-D-52C			Yes						
	DWV-D-52D			Yes						
	DWV-D-52E			Yes						
	DWV-D-52F	No								
	DWV-D-52G	No								
	DWV-D-52H	No								
	DWV-D-52I	Yes								
DWV-D-52J	No									

Table 4.5. Results on Dip Samples after Washing Procedure.

Test	Name	Secondary Phases Observed	Target Glass (wt%)				Concentration in Wash Solution, mg/L			
			F	Cl	SO ₃	ReO ₂	F	Cl	Sulfate	Re
LAWA3 [11]*	WVC-D-40A	Yes	0.03	0.33	0.44	0	0.38	17.73	45.80	<0.25
LAWC1[8]*	WVL-D-53A	Yes	0.05	0.11	0.47	0	0.49	5.83	537.09	<0.25
LAWA1[8]*	WVL-D-142A	Yes	<0.01	1.17	0.19	0	0.38	15.92	45.47	<0.25
HLW AZ-101[48]	BLE-D-71A	No	0.04	<0.01	0.07	0	0.41	11.57	8.89	<0.25
HLW C-106/AY-102 [49]	BLF-D-110B	No	<0.01	0.11	<0.01	0	0.06	0.45	1.05	<0.25
HLW SIPP [50]	BLJ-D-81A	No	<0.01	<0.01	0.19	0	0.21	3.58	2.41	<0.25
1A	WVZ-G-61C	No	0.08	0.20	0.35	0.10	0.09	1.41	2.36	<0.25
	WVZ-D-65A	No	0.08	0.20	0.35	0.10	0.10	1.13	1.35	<0.25
	WVZ-D-65C	No	0.08	0.20	0.35	0.10	0.18	1.32	2.51	<0.25
	WVZ-D-65E	No	0.08	0.20	0.35	0.10	0.14	0.22	0.65	<0.25
1B	WVZ-G-72B	No	0.08	0.20	0.41	0.10	0.14	0.38	0.67	<0.25
	WVZ-D-74A	No	0.08	0.20	0.41	0.10	0.25	2.06	2.33	<0.25
	WVZ-D-74C	Yes	0.08	0.20	0.41	0.10	6.77	41.44	10.96	<0.25
	WVZ-D-74E	No	0.08	0.20	0.41	0.10	0.17	0.43	0.59	<0.25
	WVZ-G-96B	No	0.08	0.20	0.41	0.10	0.25	0.86	2.61	<0.25
	WVZ-D-97A	No	0.08	0.20	0.41	0.10	0.42	2.94	2.01	<0.25
	WVZ-D-97C	No	0.08	0.20	0.41	0.10	0.11	3.15	3.44	<0.25
	WVZ-D-97E	No	0.08	0.20	0.41	0.10	0.15	0.49	1.36	<0.25
2A	WVZ-D-133C	No	0.08	0.20	0.41	0.10	0.40	0.45	0.55	<0.25
	WVZ-D-141C	No	0.08	0.20	0.41	0.10	0.08	0.31	0.63	<0.25
2B	AWV-D-14D	No	0.08	0.20	0.46	0.10	0.13	0.49	1.17	<0.25
2C	AWV-D-22C	No	0.08	0.20	0.53	0.10	0.18	0.42	0.60	<0.25
	AWV-D-49C	No	0.08	0.20	0.53	0.10	0.12	0.50	1.28	<0.25
	AWV-D-55C	No	0.08	0.20	0.53	0.10	0.26	0.43	0.61	<0.25

* - samples often taken after extended idling periods and therefore observations of secondary phases may not be indicative of feed or test conditions.

Table 4.5. Results on Dip Samples after Washing Procedure (continued).

Test	Name	Secondary Phases Observed	Target in Glass (wt%)				Concentration in Wash Solution, mg/L			
			F	Cl	SO ₃	ReO ₂	F	Cl	Sulfate	Re
2D	AWV-D-78C	No	0.08	0.20	0.59	0.10	0.35	0.92	1.49	<0.25
	AWV-D-78E	Yes	0.08	0.20	0.59	0.10	0.83	21.29	14.24	<0.25
	AWV-G-78A	No	0.08	0.20	0.59	0.10	0.46	0.78	0.75	<0.25
Cyclone Solids	AWV-O-86A	Yes	N/A	N/A	N/A	0.10	134.73	450.66	211.42	<0.25
3A	AWV-G-108D	No	0.08	0.20	0.59	0.10	0.26	1.40	1.26	<0.25
	AWV-D-112D	No	0.08	0.20	0.59	0.10	0.17	2.39	1.28	<0.25
	AWV-D-121C	No	0.08	0.20	0.59	0.10	0.08	0.24	1.19	<0.25
3B	AWV-D-147A	Yes	0.08	0.20	0.69	0.10	0.38	23.25	15.96	14.05
	AWV-D-147C	No	0.08	0.20	0.69	0.10	0.18	0.52	1.12	0.70
	AWV-D-155C	No	0.08	0.20	0.69	0.10	0.10	0.43	0.81	<0.25
3C	BWV-D-32D	No	0.08	0.20	0.80	0.10	0.02	0.07	0.48	<0.25
4A	BWV-D-68D	Yes	1.30	1.10	0.78	0.10	1.62	15.41	60.37	3.82
4B	BWV-D-68H	No	1.30	1.10	0.67	0.10	0.17	0.34	1.55	<0.25
	BWV-D-73C	Yes	1.30	1.10	0.67	0.10	0.84	10.78	33.24	2.00
	BWV-D-78C	No	1.30	1.10	0.67	0.10	0.18	0.26	1.14	<0.25
	BWV-D-102C	No	1.30	1.10	0.67	0.10	0.16	0.24	0.99	<0.25
4C	BWV-D-118C	Yes	1.30	1.10	0.58	0.10	14.91	116.34	220.57	18.63
	BWV-D-119C	No	1.30	1.10	0.58	0.10	0.44	1.00	1.90	<0.25
	BWV-D-142C	Yes	1.30	1.10	0.58	0.10	0.56	4.07	10.40	0.67
	BWV-D-143D	No	1.30	1.10	0.58	0.10	0.43	2.38	3.72	0.26
5A	CWV-D-26C	No	1.30	1.10	0.58	0.10	0.23	0.39	0.85	<0.25
	CWV-D-27C	No	1.30	1.10	0.58	0.10	0.18	0.67	0.99	<0.25
5B	CWV-D-32C	Yes	1.30	1.10	0.52	0.10	14.70	142.00	372.79	25.99
	CWV-D-32H	No	1.30	1.10	0.52	0.10	0.69	0.59	1.12	<0.25
	CWV-D-58C	No	1.30	1.10	0.52	0.10	0.33	1.36	2.96	<0.25

NA – Not applicable

Table 4.5. Results on Dip Samples after Washing Procedure (continued).

Test	Name	Secondary Phases Observed	Target in Glass (wt%)				Concentration in Wash Solution, mg/L			
			F	Cl	SO ₃	ReO ₂	F	Cl	Sulfate	Re
5C	CWV-D-92C	Yes	1.30	1.10	0.45	0.10	0.95	6.55	17.54	2.58
	CWV-D-92H	No	1.30	1.10	0.45	0.10	0.23	0.59	0.69	<0.25
5D	CWV-D-99C	No	1.30	1.10	0.40	0.10	0.23	0.57	0.63	<0.25
	CWV-D-125C	Yes	1.30	1.10	0.40	0.10	2.87	17.19	40.80	6.14
	CWV-D-126C	No	1.30	1.10	0.40	0.10	0.31	0.41	0.52	<0.25
6A	DWV-D-22C	No	1.30	1.10	0.40	0.10	0.26	0.47	0.63	<0.25
	DWV-D-22H	No	1.30	1.10	0.40	0.10	0.31	0.49	0.32	<0.25
6B	DWV-D-28C	No	1.30	1.10	0.35	0.10	0.40	0.86	0.72	<0.25
	DWV-D-52C	Yes	1.30	1.10	0.35	0.10	0.57	3.80	1.24	<0.25
	DWV-D-52I	Yes	1.30	1.10	0.35	0.10	0.62	0.45	0.63	<0.25

Table 4.6. Viscosity and Electrical Conductivity Data for Crucible and Melter Glasses.

<i>Glass ID</i>	LAWE3 Crucible Glass	WVZ-G-61D DM100 Melter Glass Test 1A (LAWE3 low Cl, F)	DWV-G-51B DM100 Melter Glass Test 6B (LAWE3 high Cl, F)	LAWE7H Crucible Glass	AWV-G-78A DM100 Melter Glass Test 2D (LAWE7H low Cl, F)	BWV-G-142B DM100 Melter Glass Test 4C (LAWE7H high Cl, F)	LAWE10H Crucible Glass	BWV-G-32B DM100 Melter Glass Test 3C (LAWE10H low Cl, F)
Viscosity (poise)								
950°C	544	496	408	144	217	240	364	546
1000°C	267	252	208	81	113	124	196	262
1050°C	145	139	116	49	65	70	112	140
1100°C	84	82	69	32	40	42	67	81
1150°C	52	52	44	21	26	27	42	50
1200°C	34	34	29	15	18	18	27	33
1250°C	24	24	20	11	13	13	18	22
Electrical Conductivity (S/cm)								
950°C	0.136	0.120	0.128	0.103	0.101	0.102	0.049	0.054
950°C	0.178	0.170	0.172	0.141	0.148	0.144	0.068	0.074
1000°C	0.227	0.226	0.222	0.189	0.199	0.193	0.092	0.100
1050°C	0.281	0.286	0.277	0.247	0.253	0.248	0.122	0.132
1100°C	0.340	0.348	0.338	0.317	0.308	0.309	0.158	0.170
1150°C	0.404	0.410	0.404	0.400	0.362	0.374	0.201	0.216
1200°C	0.472	0.473	0.473	0.496	0.415	0.442	0.252	0.270
1250°C	0.543	0.535	0.546	0.607	0.467	0.513	0.311	0.332

Table 4.7. Results of PCT (ASTM C1285, 7-days at 90°C) and VHT (at 200°C for 24 days) for Crucible and Melter Glasses.

Glass Sample	LAW3 Crucible Glass	WVZ-G-61D DM100 Melter Glass Test 1A (LAW3 low Cl, F)	DWV-G-51B DM100 Melter Glass Test 6B (LAW3 high Cl, F)	WTP Contract Limit
7-Day PCT, Stainless Steel Vessel; S/V=2000m⁻¹				
Concentration (ppm)				
B	59.18	44.15	85.16	-
Na	191.00	185.20	292.80	-
Si	73.49	70.76	82.66	-
7-Day PCT Normalized Concentrations (g/L)				
B	1.91	1.42	2.81	-
Na	1.41	1.37	2.27	-
Si	0.37	0.36	0.41	-
pH	11.24	11.20	11.12	-
7-Day PCT Normalized Mass Loss (g/m ²)				
B	0.95	0.71	1.40	< 2.0
Na	0.71	0.68	1.13	< 2.0
Si	0.18	0.18	0.20	< 2.0
7-Day PCT Normalized Loss Rate (g/m ² /d)				
B	0.14	0.10	0.20	-
Na	0.10	0.10	0.16	-
Si	0.03	0.03	0.03	-
VHT Alteration (24 days at 200 °C)				
Duration (days)	24	24	24	-
Alteration depth (µm)	129	175	100	-
Alteration rate (g/m ² /d) calculated using averaged density of 2.65 g/cc	14.3	19.4	11.1	< 50.0

- Empty data field

Table 4.7. Results of PCT (ASTM C1285, 7-days at 90°C) and VHT (at 200°C for 24 Days) for Crucible and Melter Glasses (continued).

Glass Sample	LAW E7H Crucible Glass	AWV-G-78A DM100 Melter Glass Test 1A (LAW E7H low Cl, F)	BWV-G-142B DM100 Melter Glass Test 6B (LAW E7H high Cl, F)	WTP Contract Limit
7-Day PCT, Stainless Steel Vessel; S/V=2000m⁻¹				
Concentration (ppm)				
B	32.72	33.18	29.24	-
Na	103.20	109.30	98.56	-
Si	81.85	88.04	73.89	-
7-Day PCT Normalized Concentrations (g/L)				
B	1.07	1.08	0.98	-
Na	1.03	1.02	1.07	-
Si	0.39	0.42	0.34	-
pH	11.14	10.98	10.72	-
7-Day PCT Normalized Mass Loss (g/m ²)				
B	0.53	0.54	0.49	< 2.0
Na	0.51	0.51	0.54	< 2.0
Si	0.20	0.21	0.17	< 2.0
7-Day PCT Normalized Loss Rate (g/m ² /d)				
B	0.08	0.08	0.07	-
Na	0.07	0.07	0.08	-
Si	0.03	0.03	0.02	-
VHT Alteration (24 days at 200 °C)				
Duration (days)	24	24	24	-
Alteration depth (μm)	152	87	63	-
Alteration rate (g/m ² /d) calculated using averaged density of 2.65 g/cc	16.8	9.6	7.0	< 50.0

- Empty data field

Table 4.7. Results of PCT (ASTM C1285, 7-days at 90°C) and VHT (at 200°C for 24 Days) for Crucible and Melter Glasses (continued).

Glass Sample	LAWE10H Crucible Glass	BWV-G-32B DM100 Melter Glass Test 1A (LAWE10H low Cl, F)	WTP Contract Limit
7-Day PCT, Stainless Steel Vessel; S/V=2000m⁻¹			
Concentration (ppm)			
B	14.08	15.28	-
Na	18.38	25.13	-
Si	47.87	56.22	-
7-Day PCT Normalized Concentrations (g/L)			
B	0.46	0.49	-
Na	0.43	0.52	-
Si	0.21	0.24	-
pH	10.25	10.22	-
7-Day PCT Normalized Mass Loss (g/m ²)			
B	0.23	0.25	< 2.0
Na	0.22	0.26	< 2.0
Si	0.10	0.12	< 2.0
7-Day PCT Normalized Loss Rate (g/m ² /d)			
B	0.03	0.04	-
Na	0.03	0.04	-
Si	0.01	0.02	-
VHT Alteration (24 days at 200 °C)			
Duration (days)	24	24	-
Alteration depth (µm)	17	20	-
Alteration rate (g/m ² /d) calculated using averaged density of 2.65 g/cc	1.9	2.2	< 50.0

- Empty data field

Table 4.8. TCLP Results (in mg/L) for Crucible and Melter Glasses.

	Blank	LAW3	WVZ-G-61D	DWV-G-51B	LAW7H	AWV-G-78A	BWV-G-142B	LAW10HR1	BWV-G-32B	UTS Limits
Ag	< 0.070	< 0.070	< 0.070	< 0.070	< 0.070	< 0.070	< 0.070	< 0.070	< 0.070	0.14
As	< 0.200	< 0.200	< 0.200	< 0.200	< 0.200	< 0.200	< 0.200	< 0.200	< 0.200	5
Ba	< 0.000	< 1*	< 1*	< 1*	< 1*	< 1*	< 1*	< 1*	< 1*	21
Cd	< 0.030	< 0.030	< 0.030	< 0.030	< 0.030	< 0.030	< 0.030	< 0.030	< 0.030	0.11
Cr	< 0.010	< 0.010	0.082	0.062	< 0.010	0.034	0.047	0.029	0.031	0.6
Ni	< 0.040	< 0.040	0.099	0.085	< 0.040	< 0.040	0.057	< 0.040	0.054	11
Pb	< 0.100	< 0.100	< 0.100	< 0.100	< 0.100	< 0.100	< 0.100	0.132	< 0.100	0.75
Se	< 0.900	< 0.900	< 0.900	< 0.900	< 0.900	< 0.900	< 0.900	< 0.900	< 0.900	5.7
Zn	< 0.020	2.202	2.185	2.631	1.307	1.583	1.502	0.748	0.786	4.3
Al	< 0.030	0.505	0.415	0.869	0.449	0.277	0.557	0.19	0.206	N/A
B	< 0.200	2.421	2.413	3.186	1.437	1.837	1.573	0.723	0.782	N/A
Ca	< 0.000	1.657	1.228	1.521	2.516	2.847	2.509	1.267	1.432	N/A
Fe	< 0.050	0.299	1.138	0.847	0.342	0.432	1.21	0.248	0.34	N/A
K	< 0.080	3.523	3.205	4.007	0.648	0.487	0.312	0.394	0.292	N/A
Li	< 0.050	< 0.050	< 0.050	< 0.050	0.744	0.908	0.782	0.479	0.566	N/A
Mg	< 0.010	0.677	0.66	0.869	0.403	0.563	0.483	0.38	0.485	N/A
P	< 0.600	< 0.600	< 0.600	< 0.600	< 0.600	< 0.600	< 0.600	< 0.600	< 0.600	N/A
Si	< 0.040	2.343	2.653	3.05	2.012	2.001	2.39	1.076	1.122	N/A
Ti	< 0.020	0.029	0.041	0.039	0.021	< 0.020	0.039	0.023	0.023	N/A
Zr	< 0.020	0.077	0.102	0.079	0.057	0.030	0.082	0.043	0.041	N/A

* Measured Ba concentration in glass TCLP extracts is relatively high due to a suspected interference.

N/A – Not applicable

Table 4.9 Descriptions of As-Melted and Heat Treated Crucible and Melter Glasses.

Formulation	Glass ID and source	Glass as-melted	Glass remelted at 1200°C for 1 hour, heat treated for 20 hours at 850°C, and quenched.	Glass remelted at 1200°C for 1 hour, and cooled according to Centerline Canister Cooling profile [51].
LAWE3	LAWE3 Crucible melt	Clear green glass	Clear green glass	Clear green glass
	WVZ-G-61D DM100 Test 1A - Nominal Cl and F	Clear green glass	Clear green glass	Clear green glass
	DWV-G-51B DM100 Test 6B – High Cl and F	Clear green glass Traces of sulfate observed	Clear green glass	Clear green glass
LAWE4H and LAWE4HK0	LAWE4H Crucible melt	Clear green glass	Clear green glass	Clear green glass
	CWV-G-125B DM100 Test 5D– High Cl and F	Clear green glass Traces of sulfate observed	NA	Clear green glass
	DWV-G-19C DM100 Test 6A– High Cl and F	Clear green glass Traces of sulfate observed	NA	Clear green glass
LAWE5H	LAWE5H Crucible melt	Clear green glass	Clear green glass	Clear green glass
	CWV-G-90C DM100 Test 5C– High Cl and F	Clear green glass Traces of sulfate observed	NA	Clear green glass
LAWE7H	LAWE7H Crucible melt	Clear green glass	Clear green glass	Clear green glass
	AWV-G-78A DM100 Test 2D - Nominal Cl and F	Clear green glass	Clear green glass	Clear green glass
	BWV-G-142B DM100 Test 4C – High Cl and F	Clear green glass Traces of sulfate observed	Clear green glass	Clear green glass
LAWE10H	LAWE10H Crucible melt	Clear green glass	~0.6 vol.% of large augite crystals	~0.1 vol.% of small augite crystals at crucible contact
	BWV-G-32B DM100 Test 3C - Nominal Cl and F	Clear green glass	~0.4 vol.% of small augite crystals at crucible contact	~0.2 vol.% of small augite crystals at crucible contact
	BWV-G-66C DM100 Test 4A – High Cl and F	Clear green glass Traces of sulfate observed	NA	~0.4 vol.% of small augite crystals at crucible contact

NA – Not analyzed

Table 5.1. Results from Melter Off-Gas Emission Samples.

		Test 1A				Test 1B			
		06/15/05 09:24 – 10:24 95.98% Isokinetic, 10.9% Moisture, 56.9 dscfm				06/17/05 10:35 – 11:35 93.8% Isokinetic, 12.3% Moisture, 61.2 dscfm			
		Feed Rate [#] (mg/min)	Emissions Rate (mg/min)	% Feed	DF	Feed Rate [#] (mg/min)	Emissions Rate (mg/min)	% Feed	DF
Particulate	Total ^{\$}	125235	1258	1.00	99.6	123130	878	0.71	140
	Al	4877	4.20	0.09	1160	4773	9.36	0.20	510
	B	4694	66.3	1.41	70.8	4595	34.4	0.75	133
	Ca	2186	1.44	0.07	1519	2662	2.98	0.11	893
	Cl*	303	158	52.0	1.9	303	154	50.7	2.0
	Cr	83	6.84	8.26	12.1	83	2.71	3.27	30.6
	F*	121	34.9	28.8	3.5	121	25.0	20.7	4.8
	Fe	5812	2.38	0.04	2442	5685	1.85	0.03	3079
	K	6259	182	2.91	34.4	0	15.4	NC	NC
	Li	0	< 0.10	NC	NC	0	< 0.10	NC	NC
	Mg	1351	0.13	0.01	10395	1324	0.18	0.01	7547
	Na	20431	181	0.88	113	23868	202	0.84	118
	Ni	12	< 0.10	< 1.0	> 120	12	< 0.10	< 1.0	> 120
	P	79	0.41	0.52	192	79	0.37	0.46	216
	Pb	14	0.19	1.35	74.3	14	0.18	1.31	76.3
	Re	129	82.2	63.7	1.6	129	74.33	57.54	1.7
	S*	212	15.2	7.17	13.9	249	18.7	7.51	13.3
	Si	30367	11.0	0.04	2769	31839	13.81	0.04	2306
	Ti	1271	3.05	0.24	417	1243	3.08	0.25	404
	Zn	4257	8.32	0.20	512	4172	9.38	0.22	445
	Zr	3362	0.64	0.02	5280	3295	0.55	0.02	6009
Gaseous	B	4694	1.11	0.02	4245	4595	9.77	0.21	470
	Cl	303	1.35	0.45	224	303	0.37	0.12	813
	F	121	0.40	0.33	300	121	2.37	1.95	51.2
	S	212	0.19	0.09	1106	249	0.18	0.07	1364

\$ - From gravimetric analysis of filters and particulate nitric acid rinses.

* - Based on analysis of water dissolution of filter particulate and acid dissolution of front-half rinse.

- Feed rate calculated from target composition and production rate.

Table 5.1. Results from Melter Off-Gas Emission Samples (continued).

		Test 2A				Test 2B			
		06/22/05 18:48 – 19:48 97.4% Isokinetic, 11.9% Moisture, 68.8 dscfm				06/24/05 18:22 – 19:22 96.7% Isokinetic, 11.7% Moisture, 62.4 dscfm			
		Feed Rate [#] (mg/min)	Emissions Rate (mg/min)	% Feed	DF	Feed Rate [#] (mg/min)	Emissions Rate (mg/min)	% Feed	DF
Particulate	Total ^{\$}	123482	945	0.77	131	122876	992	0.81	124
	Al	4749	9.55	0.20	498	4789	4.83	0.10	992
	B	4571	37.3	0.82	123	4604	43.7	0.95	105
	Ca	2640	2.64	0.10	1002	3906	4.71	0.12	830
	Cl*	303	141	46.5	2.1	303	142	46.9	2.1
	Cr	83	3.22	3.88	25.8	83	4.04	4.88	20.5
	F*	121	26.7	22.1	4.5	121	25.8	21.3	4.7
	Fe	5663	3.07	0.05	1844	5716	4.74	0.08	1206
	K	679	20.7	3.05	32.7	679	23.8	3.50	28.6
	Li	0	< 0.10	NC	NC	345	2.31	0.67	149
	Mg	1314	0.15	0.01	8666	1324	0.27	0.02	4975
	Na	23733	208	0.88	114	21285	209	0.98	102
	Ni	12	< 0.10	< 1.00	> 120	12	< 0.10	< 1.00	> 120
	P	79	0.35	0.44	228	79	0.45	0.57	176
	Pb	14	0.14	0.99	101	14	0.16	1.14	87.5
	Re	129	77.5	59.97	1.7	129	70.3	54.44	1.8
	S*	249	21.5	8.63	11.6	279	22.6	8.10	12.3
	Si	31669	18.5	0.06	1713	31846	27.9	0.09	1143
	Ti	1234	3.16	0.26	391	1243	5.72	0.46	218
	Zn	4147	8.98	0.22	462	4172	16.5	0.39	253
	Zr	3273	0.75	0.02	4368	3295	1.51	0.05	2176
Gaseous	B	4571	9.32	0.20	491	4604	9.93	0.22	464
	Cl	303	0.28	0.09	1084	303	0.24	0.08	1244
	F	121	1.60	1.32	75.8	121	2.43	2.01	49.8
	S	249	0.13	0.05	1948	279	0.14	0.05	2039

\$ - From gravimetric analysis of filters and particulate nitric acid rinses.

* - Based on analysis of water dissolution of filter particulate and acid dissolution of front-half rinse.

- Feed rate calculated from target composition and production rate.

Table 5.1. Results from Melter Off-Gas Emission Samples (continued).

		Test 2C				Test 2D			
		06/27/05 09:03 – 10:06 95.0% Isokinetic, 10.8% Moisture, 69.5 dscfm				06/29/05 14:05 – 15:05 97.4% Isokinetic, 11.5% Moisture, 68.7 dscfm			
		Feed Rate [#] (mg/min)	Emissions Rate (mg/min)	% Feed	DF	Feed Rate [#] (mg/min)	Emissions Rate (mg/min)	% Feed	DF
Particulate	Total ^{\$}	117707	1062	0.90	111	124848	839	0.67	149
	Al	4805	15.0	0.31	322	4813	3.95	0.08	1217
	B	4623	31.2	0.68	148	4633	11.9	0.26	389
	Ca	5898	12.0	0.20	491	6817	5.84	0.09	1166
	Cl*	303	161	53.1	1.9	303	152	50.2	2.0
	Cr	83	2.91	3.51	28.5	83	5.01	6.05	16.5
	F*	121	13.3	11.0	9.1	121	12.5	10.3	9.7
	Fe	5727	7.36	0.13	778	5738	2.99	0.05	1920
	K	679	24.9	3.67	27.2	679	28.8	4.24	23.6
	Li	1674	6.34	0.38	264	2229	8.64	0.39	258
	Mg	1333	0.47	0.04	2832	1360	0.20	0.01	6816
	Na	17758	191	1.08	92.9	15186	159	1.05	95.5
	Ni	12	< 0.10	< 1.00	> 120	12	< 0.10	< 1.00	> 120
	P	79	0.42	0.53	187	79	0.14	0.17	576
	Pb	14	0.14	1.02	97.8	14	< 0.10	< 1.00	> 140
	Re	129	87.1	67.40	1.5	129	88.3	68.35	1.5
	S*	322	26.6	8.26	12.1	358	41.0	11.5	8.7
	Si	31287	50.6	0.16	618	31641	20.1	0.06	1575
	Ti	1252	6.45	0.51	194	1252	2.64	0.21	475
	Zn	4196	18.8	0.45	224	4208	7.78	0.18	541
	Zr	3306	2.34	0.07	1413	3317	0.59	0.02	5634
Gaseous	B	4623	25.1	0.54	184	4633	28.2	0.61	164
	Cl	303	0.87	0.29	349	303	4.03	1.33	75.1
	F	121	19.9	16.42	6.1	121	25.4	20.93	4.8
	S	322	2.84	0.88	113	358	2.03	0.57	177

\$ - From gravimetric analysis of filters and particulate nitric acid rinses.

* - Based on analysis of water dissolution of filter particulate and acid dissolution of front-half rinse.

- Feed rate calculated from target composition and production rate.

Table 5.1. Results from Melter Off-Gas Emission Samples (continued).

		Test 3B				Test 3C			
		07/08/05 18:10 – 19:10				07/10/05 13:35 – 14:37			
		96.0 % Isokinetic, 10.6% Moisture, 69.8 dscfm				94.7% Isokinetic, 8.1% Moisture, 69.9 dscfm			
		Feed Rate [#] (mg/min)	Emissions Rate (mg/min)	% Feed	DF	Feed Rate [#] (mg/min)	Emissions Rate (mg/min)	% Feed	DF
Particulate	Total ^{\$}	132549	514	0.39	258	136019	340	0.25	400
	Al	4845	3.52	0.07	1375	4853	2.49	0.05	1952
	B	4656	10.7	0.23	435	4670	5.95	0.13	785
	Ca	7413	6.45	0.09	1149	7521	6.89	0.09	1092
	Cl*	303	67.4	22.2	4.5	303	21.8	7.19	13.9
	Cr	83	1.71	2.06	48.5	83	1.19	1.44	69.5
	F*	121	3.0	2.48	40.3	121	2.3	1.90	52.6
	Fe	5759	3.25	0.06	1771	5790	1.52	0.03	3802
	K	679	13.2	1.95	51.4	679	10.1	1.49	66.9
	Li	2869	6.23	0.22	461	2996	5.88	0.20	510
	Mg	2154	0.32	0.01	6800	2684	0.28	0.01	9460
	Na	10019	66.7	0.67	150	6414	35.7	0.56	180
	Ni	12	< 0.10	< 1.0	> 120	12	< 0.10	< 1.0	> 120
	P	79	< 0.10	< 0.15	> 790	79	< 0.10	< 0.15	> 790
	Pb	14	0.12	0.88	114	14	< 0.10	< 1.0	> 140
	Re	129	74.9	57.94	1.7	129	57.4	44.46	2.2
	S*	419	20.6	4.92	20.3	485	17.5	3.61	27.7
	Si	33085	28.0	0.08	1181	34592	14.0	0.04	2466
	Ti	1262	2.90	0.23	436	1262	2.27	0.18	555
	Zn	4220	8.59	0.20	492	4233	8.20	0.19	516
	Zr	3329	0.58	0.02	5715	3351	0.36	0.01	9239
Gaseous	B	4656	35.9	0.77	130	4670	43.1	0.92	109
	Cl	303	55.5	18.34	5.5	303	146	48.30	2.1
	F	121	37.6	31.06	3.2	121	41.3	34.12	2.9
	S	419	45.4	10.85	9.2	485	62.7	12.92	7.7

\$ - From gravimetric analysis of filters and particulate nitric acid rinses.

* - Based on analysis of water dissolution of filter particulate and acid dissolution of front-half rinse.

- Feed rate calculated from target composition and production rate.

Table 5.1. Results from Melter Off-Gas Emission Samples (continued).

		Test 4A				Test 4B			
		08/16/05 06:00 – 07:00				08/18/05 12:13 – 13:13			
		98.1% Isokinetic, 12.4% Moisture, 69.3 dscfm				98.3% Isokinetic, 11.0% Moisture, 67.6 dscfm			
		Feed Rate [#] (mg/min)	Emissions Rate (mg/min)	% Feed	DF	Feed Rate [#] (mg/min)	Emissions Rate (mg/min)	% Feed	DF
Particulate	Total ^{\$}	131193	587	0.45	223	130739	938	0.72	139
	Al	4749	1.38	0.03	3437	4741	0.85	0.02	5578
	B	4571	11.6	0.25	393	4557	19.7	0.43	231
	Ca	7358	2.81	0.04	2616	7261	1.33	0.02	5450
	Cl*	1665	88.5	5.32	18.8	1665	266	16.0	6.3
	Cr	83	2.06	2.48	40.3	83	1.91	2.30	43.5
	F*	1968	36.8	1.87	53.5	1968	42.5	2.16	46.3
	Fe	5674	1.54	0.03	3686	5642	0.77	0.01	7283
	K	666	23.5	3.53	28.3	666	38.8	5.83	17.2
	Li	2933	13.0	0.44	226	2806	17.4	0.62	161.0
	Mg	2620	0.18	0.01	14632	2109	< 0.10	< 0.01	> 21090
	Na	6279	82.6	1.32	76.0	9806	162	1.66	60.4
	Ni	12	< 0.10	< 1.0	> 120	12	< 0.10	< 1.0	> 120
	P	79	0.29	0.36	278	79	0.39	0.49	204
	Pb	14	0.35	2.48	40.3	14	0.54	3.86	25.9
	Re	129	68.1	52.67	1.9	129	90.3	69.91	1.4
	S*	473	28.3	5.98	16.7	406	40.8	10.0	10.0
	Si	33849	9.91	0.03	3415	32377	5.39	0.02	6006
	Ti	1234	1.19	0.10	1035	1234	0.67	0.05	1833
	Zn	4135	19.7	0.48	210	4123	17.2	0.42	240
	Zr	3273	0.20	0.01	16459	3250	0.13	0.00	24629
Gaseous	B	4571	53.0	1.16	86.3	4557	16.4	0.36	278
	Cl	1665	651	39.09	2.6	1665	444	26.66	3.8
	F	1968	231	11.76	8.5	1968	221	11.23	8.9
	S	473	66.9	14.12	7.1	406	43.6	10.74	9.3

\$ - From gravimetric analysis of filters and particulate nitric acid rinses.

* - Based on analysis of water dissolution of filter particulate and acid dissolution of front-half rinse.

- Feed rate calculated from target composition and production rate.

Table 5.1. Results from Melter Off-Gas Emission Samples (continued).

		Test 4C				Test 5B			
		08/20/05 15:55 – 16:22				08/26/05 20:59 – 21:29			
		99.1% Isokinetic, 12.6% Moisture, 69.4 dscfm				99.0% Isokinetic, 10.8% Moisture, 70.6 dscfm			
		Feed Rate [#] (mg/min)	Emissions Rate (mg/min)	% Feed	DF	Feed Rate [#] (mg/min)	Emissions Rate (mg/min)	% Feed	DF
Particulate	Total ^{\$}	123872	1609	1.30	77.0	117754	1732	1.47	68.0
	Al	4717	1.99	0.04	2368	4709	2.42	0.05	1950
	B	4534	29.2	0.64	155	4524	43.9	0.97	103
	Ca	6677	2.38	0.04	2803	5779	1.68	0.03	3445
	Cl*	1665	549	33.0	3.0	1665	627	37.66	2.7
	Cr	83	5.73	6.91	14.5	83	3.66	4.42	22.6
	F*	1968	56.6	2.88	34.8	1968	77.1	3.92	25.5
	Fe	5621	0.77	0.01	7320	5610	0.87	0.02	6413
	K	666	66.4	9.97	10.0	666	63.8	9.57	10.4
	Li	2180	21.4	0.98	102	1639	14.9	0.91	110
	Mg	1333	0.19	0.01	7057	1305	< 0.10	< 0.01	> 13050
	Na	14860	373	2.51	39.8	17387	404	2.32	43.1
	Ni	12	0.17	1.44	69.4	12	0.12	1.03	97.4
	P	79	4.12	5.19	19.3	79	2.32	2.93	34.2
	Pb	14	0.29	2.09	47.9	14	0.26	1.85	54.1
	Re	129	95.1	73.64	1.4	129	93.8	72.62	1.4
	S*	352	49.0	13.92	7.2	315	45.2	14.35	7.0
	Si	30969	7.32	0.02	4234	30615	7.44	0.02	4115
	Ti	1225	1.24	0.10	989	1225	1.31	0.11	939
	Zn	4111	8.72	0.21	472	4099	6.75	0.16	607
	Zr	3239	0.33	0.01	9901	3228	0.26	0.01	12417
Gaseous	B	4534	16.0	0.35	284	4524	9.73	0.22	465
	Cl	1665	272	16.34	6.1	1665	185	11.13	9.0
	F	1968	309	15.68	6.4	1968	292	14.86	6.7
	S	352	4.55	1.29	77.4	315	6.56	2.08	48.1

\$ - From gravimetric analysis of filters and particulate nitric acid rinses.

* - Based on analysis of water dissolution of filter particulate and acid dissolution of front-half rinse.

- Feed rate calculated from target composition and production rate.

Table 5.1. Results from Melter Off-Gas Emission Samples (continued).

		Test 5C				Test 5D			
		08/29/05 13:49 – 14:29				08/31/05 16:04 – 16:39			
		99.3% Isokinetic, 11.8% Moisture, 67.4 dscfm				99.1% Isokinetic, 11.0% Moisture, 69.4 dscfm			
		Feed Rate [#] (mg/min)	Emissions Rate (mg/min)	% Feed	DF	Feed Rate [#] (mg/min)	Emissions Rate (mg/min)	% Feed	DF
Particulate	Total ^{\$}	121567	2747	2.26	44.2	121064	1891	1.56	64.0
	Al	4693	12.7	0.27	370	4653	9.55	0.21	487
	B	4506	57.9	1.29	77.8	4473	54.7	1.22	81.8
	Ca	3820	20.5	0.54	187	2586	3.07	0.12	844
	Cl*	1665	692	41.6	2.4	1665	644	38.7	2.59
	Cr	83	7.61	9.18	10.9	83	3.93	4.74	21.1
	F*	1968	77.9	3.96	25.3	1968	84.4	4.29	23.3
	Fe	5589	17.4	0.31	322	5536	3.69	0.07	1501
	K	666	81.2	12.19	8.2	654	51.1	7.82	12.8
	Li	338	10.5	3.12	32.1	0	0.53	NC	NC
	Mg	1296	0.92	0.07	1403	1287	0.15	0.01	8406
	Na	20836	636	3.05	32.7	23228	496	2.13	46.9
	Ni	12	0.23	1.96	50.9	12	< 0.10	< 1.0	> 120
	P	79	2.14	2.70	37.0	79	1.50	1.89	53.0
	Pb	14	0.50	3.59	27.9	14	0.23	1.64	60.9
	Re	129	107	83.06	1.2	129	73.0	56.52	1.8
	S*	273	42.8	15.68	6.4	243	26.7	10.99	9.1
	Si	31167	95.7	0.31	326	30997	23.2	0.07	1338
	Ti	1216	10.2	0.84	119	1207	4.53	0.38	266
	Zn	4074	32.6	0.80	125	4062	12.5	0.31	325
	Zr	3217	1.62	0.05	1985	3205	0.68	0.02	4685
Gaseous	B	4506	12.2	0.27	371	4473	9.75	0.22	459
	Cl	1665	32.2	1.93	51.7	1665	33.3	2.00	50.0
	F	1968	151	7.65	13.1	1968	147	7.45	13.4
	S	273	1.76	0.64	155	243	0.80	0.33	305

\$ - From gravimetric analysis of filters and particulate nitric acid rinses.

* - Based on analysis of water dissolution of filter particulate and acid dissolution of front-half rinse.

- Feed rate calculated from target composition and production rate.

Table 5.1. Results from Melter Off-Gas Emission Samples (continued).

		Test 6A				Test 6B			
		09/14/05 10:00 – 10:35				09/16/05 13:10 – 13:50			
		103.5% Isokinetic, 11.6% Moisture, 67.1 dscfm				102.4% Isokinetic, 10.5% Moisture, 65.3 dscfm			
		Feed Rate [#] (mg/min)	Emissions Rate (mg/min)	% Feed	DF	Feed Rate [#] (mg/min)	Emissions Rate (mg/min)	% Feed	DF
Particulate	Total ^{\$}	122332	2032	1.66	60.2	118035	2382	2.02	49.6
	Al	4677	11.4	0.24	409	4773	2.98	0.06	1603
	B	4496	56.1	1.25	80.1	4595	54.0	1.17	85.2
	Ca	2608	4.05	0.16	644	2143	1.54	0.07	1395
	Cl*	1665	675	40.54	2.47	1665	693	41.6	2.4
	Cr	83	4.06	4.90	20.4	83	6.88	8.30	12.0
	F*	1968	47.5	2.41	41.4	1968	102	5.18	19.3
	Fe	5568	4.44	0.08	1253	5695	1.60	0.03	3566
	K	0	5.77	NC	NC	6120	414	6.76	14.8
	Li	0	0.23	NC	NC	0	0.14	NC	NC
	Mg	1296	0.20	0.02	6517	1324	0.14	0.01	9476
	Na	23363	520	2.23	44.9	20004	413	2.07	48.4
	Ni	12	0.13	1.07	93.7	12	0.11	0.89	112
	P	79	2.14	2.70	37.0	79	2.61	3.29	30.4
	Pb	14	0.26	1.82	54.9	14	0.24	1.71	58.6
	Re	129	79.3	61.39	1.6	129	99.8	77.23	1.3
	S*	243	25.3	10.41	9.6	212	18.3	8.63	11.6
	Si	31160	30.9	0.10	1010	29723	11.2	0.04	2666
	Ti	1216	4.95	0.41	246	1243	1.86	0.15	670
	Zn	4074	15.0	0.37	271	4160	6.01	0.14	692
	Zr	3217	0.72	0.02	4443	3284	0.29	0.01	11176
Gaseous	B	4496	10.7	0.24	422	4595	7.86	0.17	585
	Cl	1665	36.5	2.19	45.7	1665	29.5	1.77	56.5
	F	1968	189	9.61	10.4	1968	74.5	3.78	26.4
	S	243	1.12	0.46	217	212	0.60	0.28	354

\$ - From gravimetric analysis of filters and particulate nitric acid rinses.

* - Based on analysis of water dissolution of filter particulate and acid dissolution of front-half rinse.

- Feed rate calculated from target composition and production rate.

Table 5.2. Average and Range of Concentrations (ppmv) for Selected Species in Off-Gas Measured by FTIR Spectroscopy.

Test	1A		1B		2A		2B		2C		2D	
-	Avg.	Range	Avg.	Range	Avg.	Range	Avg.	Range	Avg.	Range	Avg.	Range
N ₂ O	96.4	65.9 - 139	112	< 1.0 - 277	121	<1.0 - 538	67.2	<1.0 - 95.7	84.6	4.7 - 138	79.7	22.1 - 186
NO	1179	914 - 1511	1187	2.4 - 2792	1225	2.8 - 4013	922	4.3 - 1346	840	54.5 - 1282	1085	603 - 2053
NO ₂	132	71.7 - 178	119	< 1.0 - 412	126	3.2 - 781	89.6	<1.0 - 153	52.1	2.5 - 108	116	46.0 - 330
NH ₃	39.9	21.0 - 65.0	45.0	3.2 - 147	48.4	5.1 - 351	51.6	5.7 - 80.0	58.1	2.9 - 116	21.9	<1.0 - 57.5
H ₂ O [%]	5.4	4.4 - 7.1	6.1	1.1 - 9.7	6.1	3.8 - 15.5	5.2	1.6 - 6.0	5.0	1.9 - 6.9	5.3	1.5 - 10.3
CO ₂	3000	2000-4000	2000	0 - 5000	3000	1000 - 9000	2000	0 - 7000	3000	1000 - 5000	3000	2000 - 6000
Nitrous Acid	< 1.0	<1 - 1.2	< 1.0	<1 - 1.7	<1.0	<1.0 - 3.4	<1.0	<1.0 - 1.0	< 1.0	NA	< 1.0	<1.0 - 1.4
Nitric Acid	< 1.0	NA	< 1.0	NA	<1.0	<1.0 - 1.3	< 1.0	NA	< 1.0	NA	< 1.0	NA
HCN	< 1.0	NA	< 1.0	NA	< 1.0	NA	< 1.0	NA	< 1.0	NA	< 1.0	NA
SO ₂	<5.0	NA	<5.0	NA	<5.0	NA	<5.0	NA	<5.0	NA	<5.0	NA
Acetonitrile	< 1.0	NA	< 1.0	NA	< 1.0	NA	< 1.0	NA	< 1.0	NA	< 1.0	NA
Acrylonitrile	< 1.0	NA	< 1.0	NA	< 1.0	NA	< 1.0	NA	< 1.0	NA	< 1.0	NA
CO	41.8	28.7 - 60.6	45.2	3.7 - 101	41.9	1.1 - 137	25.5	<1.0 - 35.7	42.2	1.0 - 62.6	36.3	2.1 - 90.3
HCl	< 1.0	NA	< 1.0	NA	< 1.0	NA	< 1.0	NA	< 1.0	NA	< 1.0	NA
HF	< 1.0	NA	< 1.0	NA	< 1.0	<1 - 11.2	< 1.0	<1 - 12.1	< 1.0	NA	< 1.0	<1.0 - 1.3

"-" Empty data field

Table 5.2. Average and Range of Concentrations (ppmv) for Selected Species in Off-Gas Measured by FTIR Spectroscopy (continued).

Test	3A		3B		3C		4A		4B		4C	
-	Avg.	Range	Avg.	Range	Avg.	Range	Avg.	Range	Avg.	Range	Avg.	Range
N ₂ O	78.7	<1.0 - 251	41.4	17.8 - 136	0.7	<1.0 -1.7	0.6	<1.0 – 1.9	<47.5	<1.0 - 138	73.9	<1.0 - 204
NO	1059	8.5 - 2135	439	215 - 1156	65	28.1 - 192	48.2	<1.0 – 158	379	14.8 - 1064	975	4.6 - 2021
NO ₂	109	2.3 - 292	17.4	4.1 - 132	2.6	<1.0 – 12.1	<1.0	<1.0 – 8.6	11.3	<1.0 -61.5	90.7	6.6 - 244
NH ₃	22.1	1.8 - 80.3	11.2	< 1.0 - 65.7	1.7	<1.0 – 3.3	< 1.0	NA	< 1.0	NA	< 1.0	NA
H ₂ O [%]	5.4	4.2 - 15.0	5.2	1.8 – 8.6	5.1	1.4 – 9.6	6.0	4.6 – 11.5	5.2	2.2 - 10.7	5.5	1.7 – 11.1
CO ₂	3000	1000 - 6000	2000	1000 - 6000	2000	1000 - 5000	2000	1000 - 4000	<2000	<1.0 - 6000	2000	1000 - 5000
Nitrous Acid	< 1.0	<1.0 – 1.3	< 1.0	NA	< 1.0	NA	< 1.0	NA	< 1.0	NA	<1.0	<1.0 – 1.3
Nitric Acid	< 1.0	NA	< 1.0	NA	<1.5	<1.0 -3.6	3.1	<1.0 – 6.2	<1.0	<1.0 - 5.1	<1.0	<1.0 – 1.1
HCN	< 1.0	NA	< 1.0	NA	< 1.0	NA	< 1.0	NA	< 1.0	NA	< 1.0	NA
SO ₂	<5.0	NA	<5.0	NA	<5.0	NA	<5.0	NA	<5.0	NA	<5.0	NA
Acetonitrile	< 1.0	NA	< 1.0	NA	< 1.0	NA	< 1.0	NA	< 1.0	NA	< 1.0	NA
Acrylonitrile	< 1.0	NA	< 1.0	NA	< 1.0	NA	< 1.0	NA	< 1.0	NA	< 1.0	NA
CO	37.8	2.1 - 113	12.9	2.1 – 37.6	<1.0	<1.0 – 3.6	<1.0	<1.0 – 4.0	14.4	3.1 – 51.9	47.6	5.7 - 128
HCl	< 1.0	NA	< 1.0	NA	< 1.0	NA	< 1.0	NA	< 1.0	NA	< 1.0	NA
HF	< 1.0	< 1.0 – 1.5	< 1.0	< 1.0 – 1.2	5.0	1.1 – 7.9	10.6	<1.0 – 26.0	19.7	4.9 – 39.5	19.8	12.7 – 32.2

"-" Empty data field

Table 5.2. Average and Range of Concentrations (ppmv) for Selected Species in Off-Gas Measured by FTIR Spectroscopy (continued).

Test	5A		5B		5C		5D		6A		6B	
-	Avg.	Range	Avg.	Range	Avg.	Range	Avg.	Range	Avg.	Range	Avg.	Range
N ₂ O	81.7	33.6 - 233	93.1	<1.0 - 267	59.8	1.7 - 182	124	4.6 - 727	128	18.1 - 658	107	<1.0 - 218
NO	1187	674 - 2368	1025	35.0 - 2243	936	31.6 - 2286	813	63.3 - 3750	1169	237 - 4144	1223	1.1 - 2084
NO ₂	123	56.8 - 317	100	<1.0 - 403	190	1.5 - 579	407	3.3 - 920	97.9	13.9 - 738	166	3.3 - 543
NH ₃	< 1.0	NA	<1.0	<1.0 - 22.6	<1.3	<1.0 - 21.2	7.5	<1.0 - 167	24.0	<1.0 - 172	4.8	<1.0 - 29.1
H ₂ O [%]	6.0	4.6 - 12.1	5.5	1.4 - 10.3	5.7	2.0 - 12.1	5.8	2.1 - 11.7	5.8	1.8 - 13.2	5.3	2.1 - 8.0
CO ₂	3000	2000 - 8000	3000	1000 - 7000	2000	1000 - 5000	2000	<1.0 - 8000	2000	1000 - 9000	3000	1000 - 9000
Nitrous Acid	<1.0	<1.0 - 2.0	<1.0	<1.0 - 1.4	<1.0	<1.0 - 2.6	1.7	<1.0 - 5.0	1.2	<1.0 - 4.2	<1.0	<1.0 - 3.0
Nitric Acid	<1.0	<1.0 - 2.0	< 1.0	NA	< 1.0	NA	<1.0	<1.0 - 2.2	1.7	<1.0 - 3.1	<1.0	<1.0 - 4.4
HCN	< 1.0	NA	< 1.0	NA	< 1.0	NA	< 1.0	NA	< 1.0	NA	< 1.0	NA
SO ₂	<5.0	NA	<5.0	NA	<5.0	NA	<5.0	NA	<5.0	NA	<5.0	NA
Acetonitrile	< 1.0	NA	< 1.0	NA	< 1.0	NA	< 1.0	NA	< 1.0	NA	< 1.0	NA
Acrylonitrile	< 1.0	NA	< 1.0	NA	< 1.0	NA	< 1.0	NA	< 1.0	NA	< 1.0	NA
CO	51.7	14.7 - 148	52.1	15.2 - 121	36.4	<1.0 - 95.3	52.2	3.2 - 178	48.6	5.6 - 168	40.6	3.2 - 94
HCl	< 1.0	NA	<1.0	NA	< 1.0	NA	< 1.0	NA	< 1.0	NA	< 1.0	NA
HF	16.7	5.9 - 26.1	19.3	5.6 - 34.9	8.0	<1.0 - 17.0	11.4	<1.0 - 18.9	12.9	1.2 - 27.4	13.2	<1.0 - 49.1

"-" Empty data field

Table 5.3. Average NO_x Fluxes in Off-Gas Measured by FTIR Spectroscopy.

Test	Feed [mol/hr]	Emissions				% Feed NO _x Emitted as Nitrogen Oxides
		Wet gas flow rate [scfm]	N ₂ O[mol/hr]	NO [mol/hr]	NO ₂ [mol/hr]	
1A	29.0	145	1.0	12.0	1.3	49.4
1B	31.4	143	1.1	12.0	1.2	45.6
2A	31.4	153	1.3	13.2	1.4	50.5
2B	21.8	158	0.7	10.3	1.0	55.1
2C	26.0	160	1.0	9.4	0.6	42.1
2D	21.1	161	0.9	12.3	1.3	68.7
3A	21.6	159	0.9	11.9	1.2	64.7
3B	11.2	151	0.4	4.7	0.2	47.3
3C	0.8	155	<0.1	0.7	<0.1	121.0
4A	0.8	156	<0.1	0.5	<0.1	89.3
4B	11.6	152	0.5	4.1	0.1	40.4
4C	21.4	145	0.8	9.9	0.9	54.1
5A	22.8	158	0.9	13.2	1.4	67.8
5B	26.1	149	1.0	10.7	1.0	48.8
5C	21.3	156	0.7	10.2	2.1	61.1
5D	31.2	158	1.4	9.0	4.5	47.7
6A	31.6	167	1.5	13.8	1.2	52.0
6B	29.4	164	1.2	14.1	1.9	58.7

Table 5.4. Mass Balances for Rhenium, Sulfur, Chlorine, and Fluorine During DM100 Tests (% of Feed).

Test	Glass	Element	Glass	Particle Emissions	Gaseous Emissions	Total
1A	LAWE3	Rhenium	20	63.7	< 0.1	83.7
		Sulfur	94.3	7.2	0.1	101.6
1B	LAWE4H without K	Rhenium	35	57.5	< 0.1	92.5
		Sulfur	87.8	7.5	0.2	95.5
2A	LAWE4H	Rhenium	35	60.0	< 0.1	95
		Sulfur	87.8	8.6	0.1	96.5
2B	LAWE5H	Rhenium	35	54.4	< 0.1	89.4
		Sulfur	93.4	8.1	0.1	101.6
2C	LAWE6H	Rhenium	25	67.4	< 0.1	92.4
		Sulfur	84.9	8.3	0.9	94.1
2D	LAWE7H	Rhenium	20	68.4	< 0.1	88.4
		Sulfur	91.5	11.5	0.6	103.1
3B	LAWE7H	Rhenium	35	57.9	< 0.1	92.9
		Sulfur	78.3	4.9	10.9	94.1
3C	LAWE9H	Rhenium	40	44.5	< 0.1	84.5
		Sulfur	73.8	3.6	12.9	90.3

Table 5.4. Mass Balances for Rhenium, Sulfur, Chlorine, and Fluorine During DM100 Tests (% of Feed) (continued).

Test		Element	Glass	Particle Emissions	Gaseous Emissions	Total
4A	LAWE10H	Rhenium	30	52.7	< 0.1	82.7
		Sulfur	45	6.0	14.1	65.1
		Chlorine	37.3	5.3	39.1	81.7
		Fluorine	36.2	1.9	11.8	50.0
4B	LAWE9H	Rhenium	35	69.1	< 0.1	104.1
		Sulfur	75.4	10.0	10.7	96.1
		Chlorine	60.9	16.0	26.7	103.6
		Fluorine	68.5	2.2	11.2	81.9
4C	LAWE7H	Rhenium	20	73.6	< 0.1	93.6
		Sulfur	84.7	13.9	1.3	99.9
		Chlorine	57.3	33.0	16.3	106.6
		Fluorine	68.0	2.9	15.7	86.3
5B	LAWE6H	Rhenium	25	72.6	< 0.1	97.6
		Sulfur	83.0	14.4	0.1	97.5
		Chlorine	57.3	4.4	11.1	72.8
		Fluorine	74.6	3.9	14.9	93.4
5C	LAWE5H	Rhenium	30	83.1	< 0.1	113.1
		Sulfur	89.1	15.7	0.6	105.4
		Chlorine	59.1	41.6	1.9	102.6
		Fluorine	72.3	4.0	7.7	84.0
5D	LAWE4H	Rhenium	35	56.5	< 0.1	91.5
		Sulfur	82.9	11.0	0.6	94.5
		Chlorine	60.9	38.7	2.0	101.6
		Fluorine	75.4	4.3	7.5	87.2
6A	LAWE4H without K	Rhenium	40	61.4	< 0.1	101.4
		Sulfur	82.9	10.4	10.9	104.2
		Chlorine	59.1	40.5	2.2	101.8
		Fluorine	74.6	2.4	9.6	86.6
6B	LAWE3H	Rhenium	20	77.2	< 0.1	97.2
		Sulfur	94.3	8.6	12.9	115.8
		Chlorine	61.8	41.6	1.8	105.2
		Fluorine	75.4	5.2	3.8	84.4

Figure 1.1. Schematic diagram of DuraMelter 100-WV vitrification system.

Figure 1.2(a). Cross-section through the DM100-WV melter—Plan View.

Figure 1.2(b). Cross-section through the DM100-WV melter—Section AA.

Figure 1.2(c). Cross-section through the DM100-WV melter—Section CC.

Figure 2.1. Measured viscosity of select LAW DM100 feed samples.

Figure 2.2. Comparison of measured feed rheology with proposed WTP bounds (bounds from WTP-RPT-075, Rev. 0, Feb. 2003).

Figure 3.1.a. Glass production rates during Test 1.

Figure 3.1.b. Glass production rates during Test 2.

Figure 3.1.c. Glass production rates during Test 3.

Figure 3.1.d. Glass production rates during Test 4.

Figure 3.1.e. Glass production rates during Test 5.

Figure 3.1.f. Glass production rates during Test 6.

Figure 3.2.a. Glass pool bubbling during Test 1.

Figure 3.2.b. Glass pool bubbling during Test 2.

Figure 3.2.c. Glass pool bubbling during Test 3.

Figure 3.2.d. Glass pool bubbling during Test 4.

Figure 3.2.e. Glass pool bubbling during Test 5.

Figure 3.2.f. Glass pool bubbling during Test 6.

Figure 3.3. Glass pool bubbling and glass sodium content.

Figure 3.4.a. Glass temperatures during Test 1 (hourly average data).

Figure 3.4.b. Glass temperatures during Test 2 (hourly average data).

Figure 3.4.c. Glass temperatures during Test 3 (hourly average data).

Figure 3.4.d. Glass temperatures during Test 4 (hourly average data).

Figure 3.4.e. Glass temperatures during Test 5 (hourly average data).

Figure 3.4.f. Glass temperatures during Test 6 (hourly average data).

Figure 3.5.a. Plenum temperatures and electrode power during Test 1 (hourly average data).

Figure 3.5.b. Plenum temperatures and electrode power during Test 2 (hourly average data).

Figure 3.5.c. Plenum temperatures and electrode power during Test 3 (hourly average data).

Figure 3.5.d. Plenum temperatures and electrode power during Test 4 (hourly average data).

Figure 3.5.e. Plenum temperatures and electrode power during Test 5 (hourly average data).

Figure 3.5.f. Plenum temperatures and electrode power during Test 6 (hourly average data).

Figure 3.6.a. Electrode temperatures and power during Test 1 (hourly average data).

Figure 3.6.b. Electrode temperatures and power during Test 2 (hourly average data).

Figure 3.6.c. Electrode temperatures and power during Test 3 (hourly average data).

Figure 3.6.d. Electrode temperatures and power during Test 4 (hourly average data).

Figure 3.6.e. Electrode temperatures and power during Test 5 (hourly average data).

Figure 3.6.f. Electrode temperatures and power during Test 6 (hourly average data).

Figure 3.7.a. Melt pool resistance and electrode power during Test 1.

Figure 3.7.b. Melt pool resistance and electrode power during Test 2.

Figure 3.7.c. Melt pool resistance and electrode power during Test 3.

Figure 3.7.d. Melt pool resistance and electrode power during Test 4.

Figure 3.7.e. Melt pool resistance and electrode power during Test 5.

Figure 3.7.f. Melt pool resistance and electrode power during Test 6.

Figure 3.8. Melt pool resistance and feed sodium content.

Figure 4.1. XRF analysis of Na₂O and SiO₂ in melter glasses.

Figure 4.2. XRF analysis of oxides in product glasses which are constant during testing.

Figure 4.3. XRF analysis of oxides in product glasses which vary during testing.

Figure 4.4. XRF analysis of sulfur in melter glasses.

Figure 4.5. XRF analysis of chlorine in melter glasses.

Figure 4.6. XRF analysis of fluorine in melter glasses.

Figure 4.7. XRF analysis of rhenium in melter glasses.

Figure 4.8. Dip samples from Test 6A. Note separated sulfur on two rods in the back right buckets.

Figure 4.9. Separated sulfur on dip sample DWV-D-22A from Test 6A.

Figure 4.10. Dip samples from Test 6A removed from rods and placed in Petri dishes for examination.

Figure 4.11. Separated sulfur on dip sample DWV-D-22A from Test 6A after removal from rod.

Figure 4.12. Separated sulfur remaining on rods after glass removal during Test 4B.

Figure 4.13.a. Back scattered electron image taken at 1000X magnification on WVZ-D-74C.

Figure 4.13.b. Spectra from secondary phases in WVZ-D-74C.

Figure 4.14.a. SEM micrograph of secondary phases in BWV-D-68E. Note that the material consists of two distinct phases: a substrate and crystals which protrude from the substrate.

Figure 4.14.c. Spectrum from protruding crystals on secondary phases of BWV-D-68E.

Figure 4.15 Melt viscosity (at 1100 °C) for formulations tested as crucible melts (LAWE3, LAWE7H, and LAWE10H) and DM100 melter glasses with nominal (WVZ-G-61D, AWW-G-78A, BWV-G-32B) and increased halides (DWV-G-51B, BWV-G-142B).

Figure 4.16 Melt electrical conductivity (at 1100 °C) for formulations tested as crucible melts (LAWE3, LAWE7H, and LAWE10H) and DM100 melter glasses with nominal (WVZ-G-61D, AWW-G-78A, BWV-G-32B) and increased halides (DWV-G-51B, BWV-G-142B).

Figure 4.17 PCT normalized mass loss (for boron and sodium) for formulations tested as crucible glasses (LAWE3, LAWE7H, and LAWE10H) and DM100 melter glasses with nominal (WVZ-G-61D, AWV-G-78A, BWV-G-32B) and increased halides (DWV-G-51B, BWV-G-142B).

Figure 4.18 Alteration rate given by Vapor Hydration Test (at 200 °C) for formulations tested as crucible glasses (LAWE3, LAWE7H, and LAWE10H) and DM100 melter glasses with nominal (WVZ-G-61D, AWV-G-78A, BWV-G-32B) and increased halides (DWV-G-51B, BWV-G-142B).

Figure 4.19. TCLP zinc concentration for formulations tested as crucible glasses (LAWE3, LAWE7H, and LAWE10H) and DM100 melter glasses with nominal (WVZ-G-61D, AWW-G-78A, BWV-G-32B) and increased halides (DWV-G-51B, BWV-G-142B).

Figure 5.1. Measured particle emission rate from the DM100 as a function of feed sodium content.

Figure 5.2. Measured sodium emission rate from the DM100 as a function of feed sodium content.

Figure 5.3. Measured rhenium emission rate from the DM100 as a function of feed sodium content.

Figure 5.4. Measured chlorine emission rate from the DM100 as a function of feed sodium content.

Figure 5.5. Measured fluorine emission rate from the DM100 as a function of feed sodium content.

Figure 5.6. Percent sulfur carryover from the DM100 as a function of feed sodium content.

Figure 5.7.a. Nitric oxide concentrations in off-gas from FTIR during Test 1.

Figure 5.7.b. Nitric oxide concentrations in off-gas from FTIR during Test 2.

Figure 5.7.c. Nitric oxide concentrations in off-gas from FTIR during Test 3.

Figure 5.7.d. Nitric oxide concentrations in off-gas from FTIR during Test 4.

Figure 5.7.e. Nitric oxide concentrations in off-gas from FTIR during Test 5.

Figure 5.7.f. Nitric oxide concentrations in off-gas from FTIR during Test 6.

Figure 5.8.a. NO₂ concentration in off-gas from FTIR during Test 1.

Figure 5.8.b. NO₂ concentration in off-gas from FTIR during Test 2.

Figure 5.8.c. NO₂ concentration in off-gas from FTIR during Test 3.

Figure 5.8.d. NO₂ concentration in off-gas from FTIR during Test 4.

Figure 5.8.e. NO₂ concentration in off-gas from FTIR during Test 5.

Figure 5.8.f. NO₂ concentration in off-gas from FTIR during Test 6.

Figure 5.9.a. CO concentration in off-gas from FTIR during Test 1.

Figure 5.9.b. CO concentration in off-gas from FTIR during Test 2.

Figure 5.9.c. CO concentration in off-gas from FTIR during Test 3.

Figure 5.9.d. CO concentration in off-gas from FTIR during Test 4.

Figure 5.9.e. CO concentration in off-gas from FTIR during Test 5.

Figure 5.9.f. CO concentration in off-gas from FTIR during Test 6.

Figure 5.10.a. Ammonia concentration in off-gas from FTIR during Test 1.

Figure 5.10.b. Ammonia concentration in off-gas from FTIR during Test 2.

Figure 5.10.c. Ammonia concentration in off-gas from FTIR during Test 3.

Figure 5.10.d. Ammonia concentration in off-gas from FTIR during Test 5.

Figure 5.10.e. Ammonia concentration in off-gas from FTIR during Test 6.

Figure 5.11.a. Hydrogen fluoride concentration in off-gas from FTIR during Test 4.

Figure 5.11.b. Hydrogen fluoride concentration in off-gas from FTIR during Test 5.

Figure 5.11.c. Hydrogen fluoride concentration in off-gas from FTIR during Test 6.